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6470.29A

MAINTENANCE OF EN ROUTE AIR-TO-GROUND COMMUNICATIONS FACILITIES

AUGUST 7, 1985

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Distribution: Selected Airway Facilities Field and Regional Offices, ZAF-600

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FOREWORD

1. PURPOSE.
This handbook provides guidance and prescribes technical standards and tolerances and procedures applicable to the maintenance and inspection of en route air-to-ground (a-g) communications facilities. It also provides information on special methods and techniques that will enable maintenance personnel to achieve optimum performance from the equipment. This information augments information available in instruction books and other handbooks and complements Order 6000.15A, General Maintenance Handbook for Airway Facilities.

2. DISTRIBUTION.
This directive is distributed to selected offices and services within Washington headquarters, the FAA Technical Center, the Mike Monroney Aeronautical Center, regional Airway Facilities divisions, and Airway Facilities field offices having the following facilities/equipment: ARTCC, CERAP, RCAG.

3. CANCELLATION.
Order 6470.29, Maintenance of En Route Air/Ground Communications Facilities.

4. MAJOR CHANGES.
This order revises, updates, and expands maintenance information from cancelled order 6470.29. Field comments have been incorporated with the following major changes:

a. Standards and tolerances are updated to conform with accepted field suggestions.

b. Obsolete maintenance procedures and standard and tolerance values are deleted.

c. Solid-state equipment maintenance periodicity is revised.

Martin T. Pozesky
Director, Program Engineering and Maintenance Service

(Page revised 7/5/90 by CHG 4)

5. MAINTENANCE AND MODIFICATION POLICY.

a. Order 6000.15A, this order, and the applicable equipment instruction book shall be consulted and used by the maintenance technician in all duties and activities for the maintenance of enroute a-g communications facilities. These documents shall be considered collectively as the single official source of maintenance policy and direction authorized by the Program Engineering and Maintenance Service. References located in the chapters of this order entitled Standards and Tolerances, Periodic Maintenance, and Maintenance Procedures shall indicate to the user whether this order and/or the equipment instruction book shall be consulted for a particular standard key inspection element or performance parameter, performance check, maintenance task, or maintenance procedure.

b. Order 6032.1A, Modifications to Ground Facilities, Systems, and Equipment in the National Airspace System, contains comprehensive policy and direction concerning the development, authorization, implementation, and recording of modifications to facilities, systems, and equipment in commissioned status. It supersedes all instructions published in earlier editions of maintenance technical handbooks and related directives.

6. FORMS LISTING.
Use FAA Form 6600-6, Technical Performance Record, VHF/UHF Air/Ground Receivers/Transmitters, to record the performance of local emergency and remote backup emergency communications (BUEC) and remote center a-g (RCAG) transmitters and receivers. The form is available under NSN 0052-00-689-4000, unit of issue: PD.

7. RECOMMENDATIONS FOR IMPROVEMENT.
Preaddressed comment sheets are provided at the back of this handbook in accordance with Order 1320.40B, Expedited Clearance Procedures for Airway Facilities Maintenance Directives. Users are encouraged to submit recommendations for improvement.

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CHAPTER 1. GENERAL INFORMATION AND REQUIREMENTS

1. OBJECTIVE.

This handbook provides the necessary guidance, to be used in conjunction with information available in instruction books and other handbooks, for the proper maintenance of en route air-to-ground (a-g) communications systems.

2. AIRCRAFT ACCIDENT.

* Among the responsibilities of the Operational Support Directorate in the investigation of an aircraft * accident are the evaluation and documentation of the technical performance of the facilities that were, or might have been, involved in the accident. This requires that facility operational data be obtained and recorded in the maintenance logs and performance record forms. These recorded data are official documents and may be used by an aircraft accident investigation board in the determination of facility operational status at the time of the accident. To avoid any misinterpretation of the data, the entries shall be complete, clear, concise, and accurate. Order 8020.11, Aircraft Accidents and Incidents — Notification, Investigation and Reporting, should be consulted for details. The following must be obtained and recorded for any a-g communication facilities involved in an aircraft accident.

a. No equipment adjustments are to be made until the as-found readings are recorded and/or after the flight check, if required, is accomplished.

b. Check the operating equipment record to ascertain whether there has been a changeover in equipment. If a changeover has occurred, both sets of equipment must be checked.

c. Record all meter readings as found, but make no adjustments until after required flight inspection actions are completed.

d. Check voice modulation level.

e. Certify the meter readings and the log entry. Have another technician or the supervisor also certify the log entry.

f. Note any abnormal conditions, such as snow or ice on antennas or insulators.

g. If a check of the engine generator elapsed-time meter indicates that the generator has operated since the last visit, determine that the engine generator will start and run on a no-load test run. As soon as practicable, a full-load test shall be made and all meter readings recorded.

* **h.** When operating in the voice switching and control system (VSCS) mode, the following minimum data must be obtained and recorded for any Air Traffic Control (ATC) functionality involved in an aircraft accident:

(1) Check the VSCS operating equipment record to ascertain that there has been no changeover in equipment. If a changeover has occurred, both sets of equipment must be checked. The following data must be extracted from the system in support of the accident/incident investigation 10 minutes prior to the time of the reported incident and 10 minutes after the reported incident.

(a) Chatterlog data

(b) Maintenance log data

(c) Traffic data log

(d) Exception report file data

(2) If any system component failed or was mode transitioned from the on-line primary state to any other state during the 10 minute window prior to or after the estimated time of an incident, that component will be placed in the on-line primary state, verified with an operational a-g check, and system recertified. *

3. RECEIVER SENSITIVITY AND TRANSMITTER POWER OUTPUT ADJUSTMENT POLICY.

* The basic policy of Operational Support advocates * standardization in system adjustment and performance. However, operational requirements and environmental factors can impose constraints that demand deviation from system equipment standards. This paragraph contains policy guidance relating to the operational setting of very-high frequency/ultrahigh frequency (vhf/uhf) receiver radio frequency (rf) gain controls and to the authorized rf power output levels of vhf/uhf transmitters. Since operational situations that necessitate changes in these system

parameters after facility commissioning may develop, the responsible AF field office implementing the change must coordinate with the concerned Air Traffic (AT) and Flight Standards (FS) field offices and fully document the details of the changes made.

a. Squelch Threshold and RF Gain Control Setting. Ideally, the rf gain control of all vhf and uhf receivers should be adjusted for the maximum setting, or slightly below the point where noise signals operate the squelch circuit. Unfavorable noise or interference which exists at, or arises subsequent to, commissioning requires a reduced sensitivity setting of the rf gain control for satisfactory receiver quieting. Operation at a reduced setting is authorized, provided that reception range and coverage needed to meet operational requirements have been verified by aircraft contact reports or mathematical analysis and that appropriate initial and operating tolerances are developed, approved, and published by the regional Airway Facilities division.

b. Transmitter Power Output. Ordinarily, transmitters used in a-g communication service shall be * adjusted to emit rated rf carrier-power output. However, * interference may arise and require operation at a reduced rf carrier-power output level. Reduced-power output operation may also be required for equipment-related reasons. (See standards and tolerances for transmitter power output in Order 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.) Operation at a reduced rf carrier-power output level is authorized, provided that the transmission range and coverage meet operational requirements as verified by aircraft reports and that appropriate tolerances which are comparable to those in Order 6580.5 are developed.

4. CERTIFICATION REQUIREMENTS. Order 6000.15B provides general guidance for the certification of systems, subsystems, and equipment. Appendix 1 of this handbook includes the specific certification requirements of the en route air-to-ground communication systems.

5. INTERSITE LINE AND RADIO LINK CIRCUIT MAINTENANCE REQUIREMENTS.

a. Telephone circuits. Periodic frequency response, noise measurements, and circuit net loss at 1000 Hz are to be entered on the forms specified in Order 6000.22, Maintenance of Two Point Private Lines. The forms provided by the handbook cover performance of the FAA-S-1142a line. Digitally controlled communication facilities do not require FAA-S-1142a lines and shall use unconditioned voice grade lines in accordance with manufacturer's handbook for the equipment.

b. Link Voice Channels. Discrepancies in unity gain, instability in vhf or radar microwave link (RML) components, and path fade have made air-to-ground service over link voice channels a matter of concern. To prevent this means of transmission from degrading performance, close attention must be given to link voice channel lineup techniques and levels and in overall link maintenance. (See paragraph 48 for maintenance handbook references.)

6. PRECAUTIONS WHEN USING TEST TONES. When making checks on any receiving channel, extreme care shall be taken to avoid applying test tones or other signals in excess of those prescribed by the procedures of this directive. Not only will excessive test levels cause crosstalk in adjacent telco or RML channels, but also annoyance to operating personnel may occur if the interfering signals are delivered to controller positions or are intercepted by maintenance personnel at other points in the system.

7. NONSTANDARD FACILITIES.

a. The instructions, description, standards and tolerances, and procedures contained in this directive represent the agency's baseline, or standard criteria, concerning the en route a-g communication equipment. Some facilities under the purview of this directive may have been commissioned using equipment which has been procured without the benefit of agency approved specifications. Regional procurement of equipment and devices to be used for air traffic control or navigation for which specifications have not received prior agency approval is prohibited by Order 1100.5C, FAA Organization – Field, paragraph 222j(2). The inclusion of such nonstandard equipments in this directive is for maintenance purposes only and as such will not be used as justification for procurement, installation, or commissioning of additional or similar equipment.

b. Request for changes to nonstandard facilities/ equipment under configuration management as prescribed in NAS-MD-001 may be requested via the submittal of a NAS Change Proposal, FAA Form 1800-2.

c. Request for changes to established National standards and tolerances as set forth in this maintenance handbook may be submitted via pre-addressed comment sheets attached to the back of the * handbook. *

8. SYSTEM CONCEPT.
This directive provides the description, standards and tolerances, periodic maintenance, and maintenance procedures for an entire en route a-g communication. Various maintenance technical orders that are referenced throughout this directive contain equipment or other description, standard and tolerances, periodic maintenance, and maintenance procedures necessary to support the system. This order supersedes any conflicting information regarding standards and tolerances, periodic maintenance task, or procedure already contained in a referenced order or instruction book.

9. CONVERSION TO ZERO LOSS LINES.

a. **Master Demarcation System (MDS).** The master demarcation system (MDS) is the physical point of separation between communication systems that leave the ARTCC (telco, RCL) and user equipment located within the ARTCC. The MDS consists of wiring frames and jackfields designed to provide a centralized location for circuit patching, circuit testing, and trouble isolation.

b. **Mini Demarcation System (mds).** The mini demarcation system (mds) is the physical point of separation between communication systems that leave the remote air-to-ground facility (telco, RCL) and user equipment located within the RCAG. The mds consists of terminal blocks, jackfield, and loopback equipment. It is designed to provide a centralized location for local and remote circuit testing and trouble isolation.

c. **Zero Loss Lines (ZL^2).** Zero loss lines are characterized as leased telephone company (telco) four-wire circuits with 0 dB nominal loss at 1000 hertz. FAA policy requires the installation of ZL^2 as the national * standard for all future leased telco circuits. *

d. **Zero Transmission Level Point (0 TLP).** The zero transmission level point (0 TLP) is the point in a communication circuit to which all relative levels at other points in the circuit are referred. For simplicity and to improve the overall circuit signal to noise ratio, 1000 hertz, 0 dBm, test tone will be established as the nominal alignment signal power level at the 0 TLP. To the extent possible the 0 TLP point will be established at the master demarcation system (MDS).

10.-19. RESERVED.

CHAPTER 2. TECHNICAL CHARACTERISTICS

20. PURPOSE OR FUNCTION.

The en route air-to-ground (a-g) communications system provides a medium of communication between a controller and a pilot for air traffic control purposes.

21. DESCRIPTION.

The system consists of three major types of facilities: air route traffic control center, the remote center air-to-ground communication facility (RCAC), and the backup emergency communication (BUEC) remote outlets. The RCAG's and the BUEC outlets may he located several hundred miles from the center to which they are connected by leased landlines or FAA-owned radio link circuits.

a. Air Route Traffic Control Center (ARTCC). The ARTCC is located in a building housing administrative offices, equipment rooms, and the operations room. Figure 2-1 is an overall view of a-g communications that are tributary to an ARTCC. Figures 2-2 and 2-2A are simplified block diagrams of a-g and supporting telecommunications circuits of the ARTCC and remote facilities.

(1) Channel Operation.

(a) Split-channel operation, shown in figure 2-3, requires two VFSS and two FAA-S-1142a circuits to obtain independent operation of the very-high frequency (vhf) and ultra-high frequency (uhf) channels.

(b) Selective-channel operation, shown in figure 2-4, requires one VFSS and an FAA-S-1142a circuit to control both the vhf and uhf channels. Transmission control permits either simultaneous or individual vhf/uhf channel control. Using this system, a controller keying one channel denies the other channel to another controller.

(c) Paired-channel. Operation is similar to selective-channel operation except that both the vhf and uhf channels are keyed simultaneously.

(2) VSCS Mode of Operation. The VSCS provides air-to-ground (a-g) voice channel connectivity between air traffic controllers and pilots, and provides ground-to-ground (g-g) intercom, communication (intercom), and interphone (intph) voice connectivity between air traffic controllers within the Air Route Traffic Control Centers (ARTCC) and controllers in adjacent facilities.

(a) Hardware Description. The VSCS is an integrated a-g and g-g voice and radio switching and control system for ARTCC and Terminal Radar Approach Control (TRACON) facilities. The VSCS permits selection, interconnection, activation, and reconfiguration of communication paths between the controller positions, a-g and g-g communications resources. The VSCS initiates keying of external a-g radios, switches between redundant equipment and circuits, and indicates and confirms status of remote communications resources. The VSCS accommodates a range of facility sizes from 50 to 430 ATC console positions, and consists of five subsystems, each performing a distinct set of functions in support of the VSCS requirements. The VSCS consists of five hardware subsystems or hardware configuration items (hwci) and five computer software subsystems or computer software configuration items (CSCI). Each subsystem supports a distinct set of functions in support of the VSCS requirements.

1 Console Equipment Subsystem (Hwci-1). The VSCS console equipment (VCE) provides the computer human interface (CHI) between the VSCS and the air traffic controller. This subsystem provides control of and access to the a-g and g-g communication functions. The hardware includes touch sensitive displays, data entry devices, voice transducer devices, and a central processing unit (CPU). The VSCS console equipment (VCE) interfaces with the control subsystem for diagnostic reporting, position adaptation and software downloads, and for status and traffic logging. It provides voice data to the high capacity voice recorder (HCVR) subsystem as a legal record, and for training and evaluation of controller equipment.

2 Switching Subsystem (Hwci-2). The switching subsystem provides the air traffic controller the capability of selecting local and remote radio transmitters/receivers via the Grim Cooperation Equipment (GRIM), Intellect, backup emergency communications (BUEC) and routing a-g audio communication to/from the console

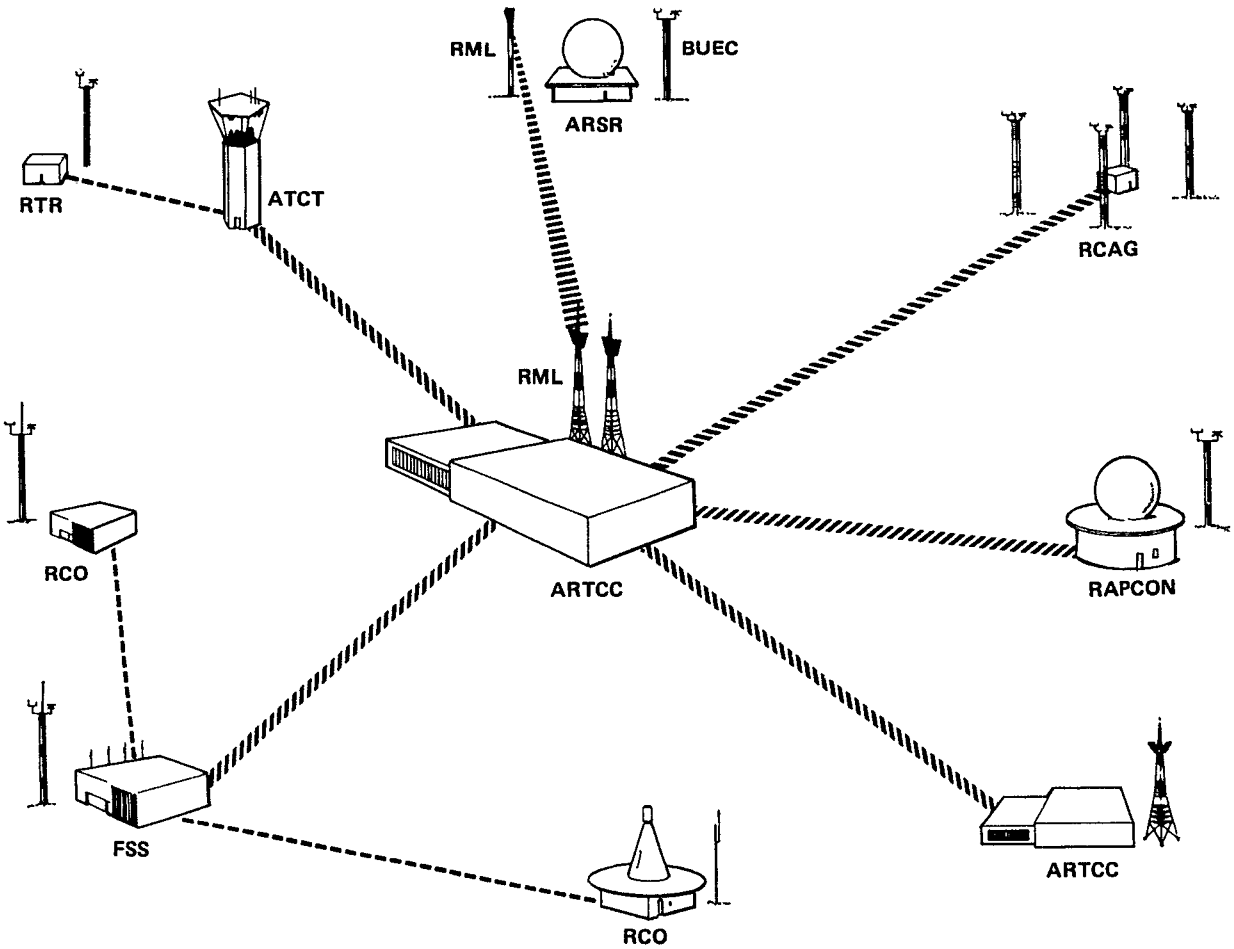

Figure 2-1. The ARTCC and Its Tributary Facilities

equipment. The switching subsystem provides g-g communication capabilities via intercom and interphone functions, access to external networks via the private automatic branch exchange (PABX), and the Federal Telephone System (FTS). The VSCS incorporates the Harris 20/20 single-circuit (SC) digital switch and has three configurations, a-g position node (p-node), a-g radio node (r-node), and the g-g node. Each node configuration supports a specific configuration of communication circuits.

3 Maintenance Position Equipment System (MPES) (Hwci-3). The MPES is a maintenance workstation area for use by the system maintenance operator. From this position the maintenance operator monitors the system's health, performs failure recovery actions, isolates equipment faults, troubleshoots the system, and generates maintenance reports. The MPES includes built-in-test equipment (BITE) which is capable of providing the maintenance technician access to all switch nodes and console equipment for automated voice channel testing (VCT).

4 Control Subsystem (Hwci-5). The control subsystem provides support of system management functions, configuration database maintenance, and the ability to monitor the status and control of all VSCS subsystem components. The control subsystem hardware consists of the tandem CLX computer, discrete monitor and controller (DMC), personnel computer (PC) based workstations. Processing capabilities and mass storage resources for VSCS software are furnished for all system activities. Redundant a-g and g-g local area networks (LAN) interconnect the various VSCS subsystems providing status monitoring, map adaptation, and software downloads.

5 System Interconnect Subsystem (SIS) (Hwci-7). The SIS provides the signal connections between all stand-alone cabinets and unit pieces of equipment. The SIS includes power cables, signal cables, intermediate distribution frames, patch panels, a-g, g-g and workstation LAN connections, power conditioners, and system cables.

(b) Software Description. The following paragraphs briefly describe the five computer software configuration items (CSCI).

1 On-line Operations Control (CSCI-l). The on-line operations control software is used for overall on-line control of the VSCS. This software interfaces with the external interfaces, controls the AT supervisor's point of entry for ordering and managing reconfigurations, and the NAS operations manager/maintainer's interface for monitoring system performance in the way of on-line diagnostics.

2 G-G Switch Control (CSCI-2). The g-g switch control subsystem software resides in each g-g switch node. This software subsystem provides voice switching control features for g-g communications. It provides all voice interconnections among positions within the ATC facility, between facilities and positions at other facilities, between position in a facility, and designated PABX tie lines. This software subsystem provides all g-g call features and connectivity, and reports status to the on-line control subsystem.

3 Common Console Communications Control (CSCI-4). The VCE subsystem software contains the direct system interface for the operator at the position console and driver for the various display screens available to the operator. This software receives and interprets operator touch entry actions and controls the state of the display for a-g calls, g-g calls, and other communication functions. It continually runs background tests and reports status and traffic to the on-line control subsystem.

4 A-G Switch Control (CSCI-5). The a-g switch control subsystem software controls a direct interface to the existing radios. This software provides selection and control of radio transmitters and receivers located at both local and remote sites from ATC positions via the existing radios. This software subsystem also provides confirmation indications for a-g communications operations to the VCE subsystem, reports status to the control subsystem, and provides the controlling interface to the a-g switch hardware.

5 Off-line Support Services (CSCI-6). Based in the control subsystem, the off-line support software is used to edit the system configuration map database, reduce traffic data, and run fault isolation diagnostic and verification tests. These support functions are accessed from the control subsystem workstations and operations console.

(3) VSCS Emergency Access Radio System (VEARS). VEARS provides a direct path to primary frequencies used to cleanse airspace in the event of a catastrophic failure of the VSCS. The following paragraphs describe WARS:

(a) VEARS provides an independent path to the primary remote communications air-ground facility (RCAG) by interfacing with the radio control equipment (RCE). There is no independent path provided to the backup emergency communications (BUEC) or local radio.

(b) VEARS is activated by the insertion of a headset jack into the VEARS module. It will provide paired keyed vhf/uhf operation. Main/Standby radios, receive volume, push-to-talk (ptt), and a legal recorder interface are provided at each operator position. System design has been kept simple to ensure a high level of reliability.

(c) VEARS consists of a single, dual, or quad module, multi-pair cables, ancillary speakers, and a radio control adapter (RCA)/patch rack. There is no software in the system. The single module provides access to one frequency pair per sector. The dual module will accommodate dual diversity frequencies; a selector switch will allow interface of VEARS with either of two sites. The quad or four-channel module provides for multiple frequencies with independent access to satisfy coverage in large airspace sectors.

b. Control Circuits. The control circuits between the ARTCC and RCAG are vhf or microwave link circuits, FAA cable, leased telephone circuits, or a combination of these circuits.

c. Remote Center Air-to-Ground Communication Facility (RCAG). The RCAG facility provides remote transmitting and receiving capability for the center. The RCAG uses ground-based vhf and uhf transmitting/ receiving antennas that are usually mounted on towers. Each RCAG has one or more radio channels operating in the vhf and uhf bands. The vhf (118 MHz to 136 MHz) communication channels are for civil aviation use, and the uhf (225 MHz to 400 MHz) channels are for military aviation use.

* **d. BUEC.** The backup emergency communication (BUEC) subsystem provides backup emergency en route * channels by using remote vhf and uhf solid-state transceivers or transmitter/receiver pairs. The original BUEC system, consists of ITT transceivers and control equipment. The replacement system consists of Motorola CM-200 transmitter/receiver pairs and CSTI CS-2330 radio control equipment. *

(1) These channels are accessed by a control unit actuated directly from an air traffic controller's operating position. * The BUEC remote outlet can be located at any facility that provides the required coverage. The typical BUEC remote outlet is located at a VHF Omnidirectional Range (VOR) or long-range radar (LRR) facility. Either RCL, LDRCL, FAATSAT or voice-grade telco circuits are used between the ARTCC and the remote outlet to provide transmission of * speech, transmitter keying, and tuning tone signals (original BUEC). Details of the original BUEC subsystem and its equipment are contained in the BUEC instruction book. The BUEC maintenance directive is Order 6500.9A, Maintenance of Backup Emergency Communication (BUEC) Facilities. A simplified BUEC block diagram is shown in figure 2-5.

* (2) When operating in the VSCS mode, the BUEC interface provides air traffic control access to the existing BUEC subsystem of emergency vhf and uhf en route channels. These channels are accessed by the controller via either of the VCE VSCS display modules (VDM's). Tuning of ARTCC BUEC * frequencies is accomplished by the VSCS switching subsystem and controller position configuration maps. A simplified BUEC block diagram with the VSCS interface is shown in * figure 2-5A.

(3) In the Motorola/CSTI equipment configuration, a control unit interfaces with the VSCS and a remote unit interfaces with the radios. Control signals and audio signals are passed between the two units via an internal modem and telephone or RCL circuit. The radios in this configuration are fixed frequency. Currently, the radio control equipment does not support split frequency operation. The maintenance directives for this equipment include Order 6650.4D, Maintenance of Voice Frequency Signaling System (VFSS) and Order * 6580.5, Maintenance of Remote Communication Facility (RCF) Equipments.

22.-29. RESERVED.

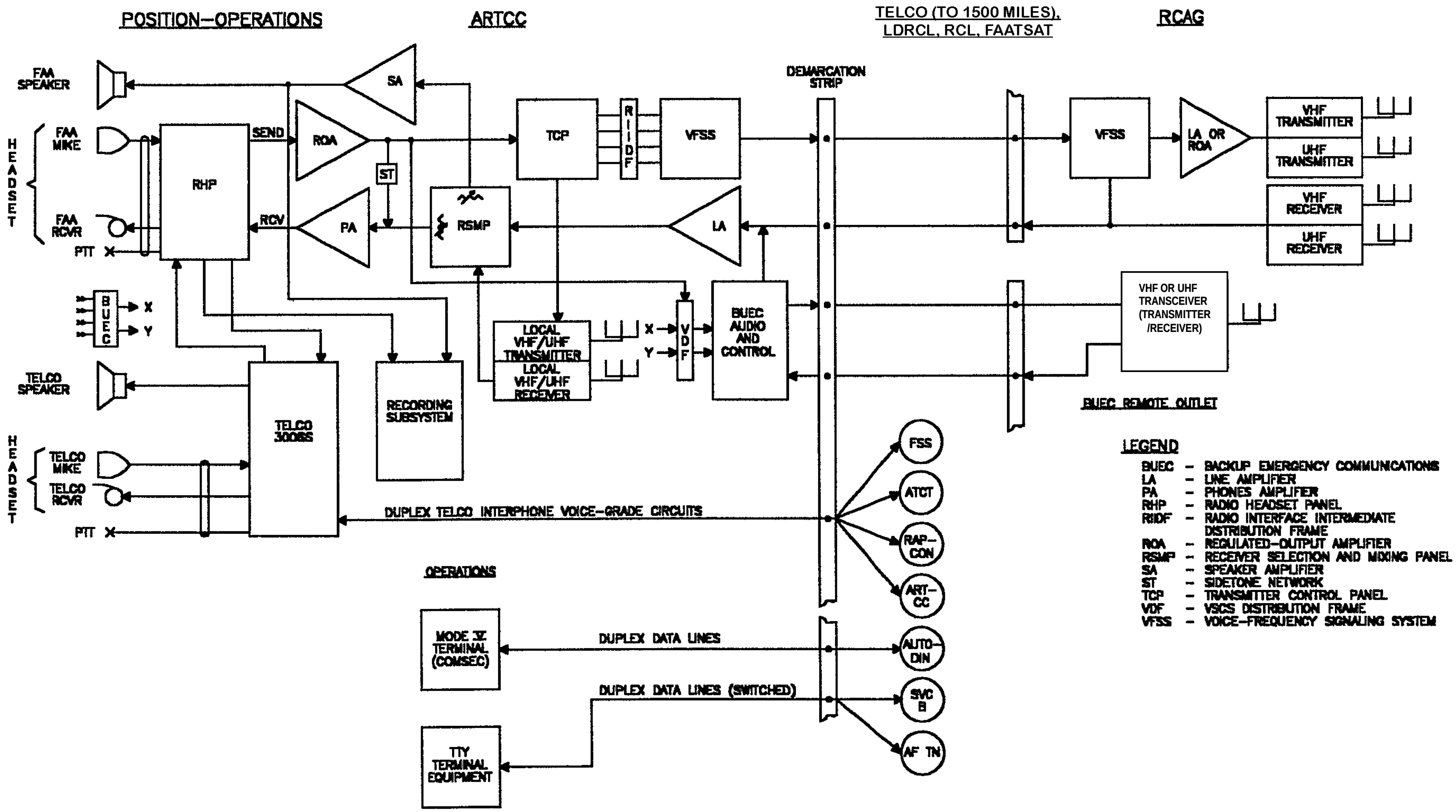

Figure 2-2. Air-to-Ground En Route Communications, Simplified Block Diagram

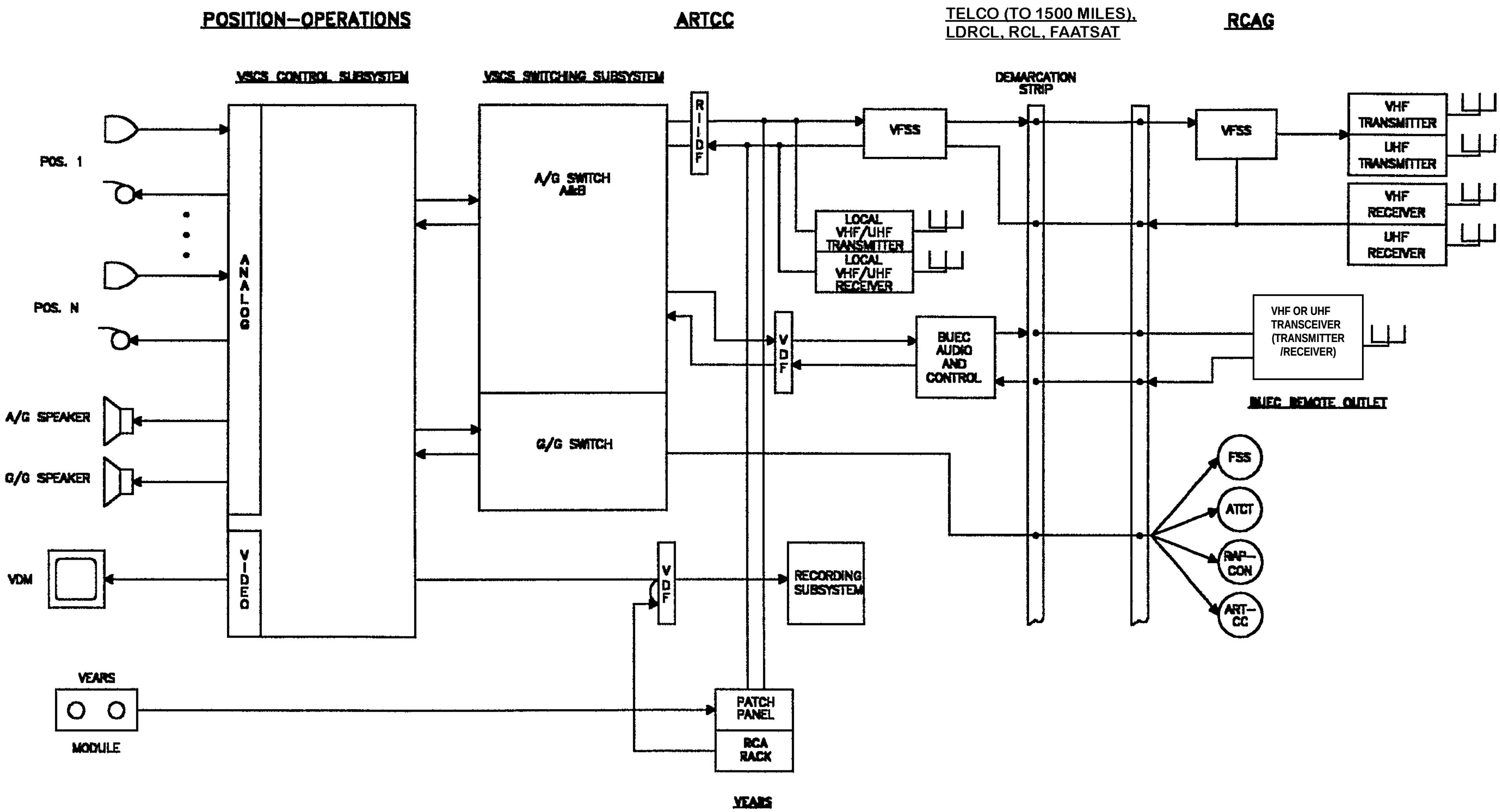

Figure 2-2A. VSCS Air-to-Ground En Route Communications, Simplified Block Diagram

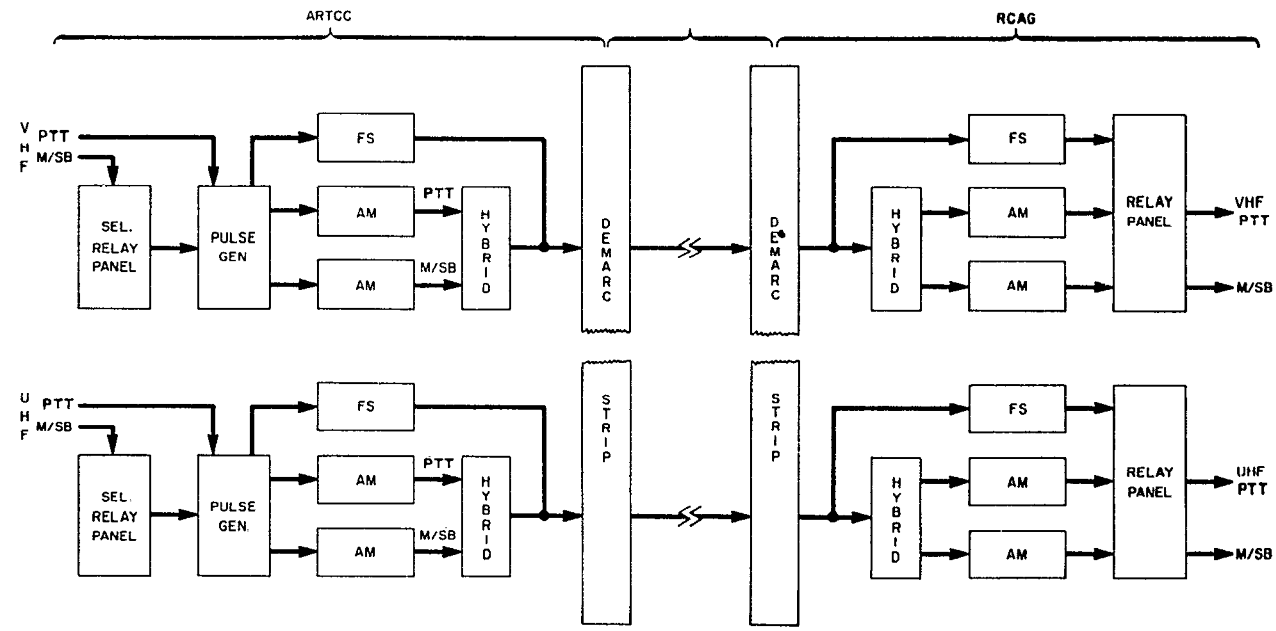

Figure 2-3. Split-Channel Operation Block Diagram

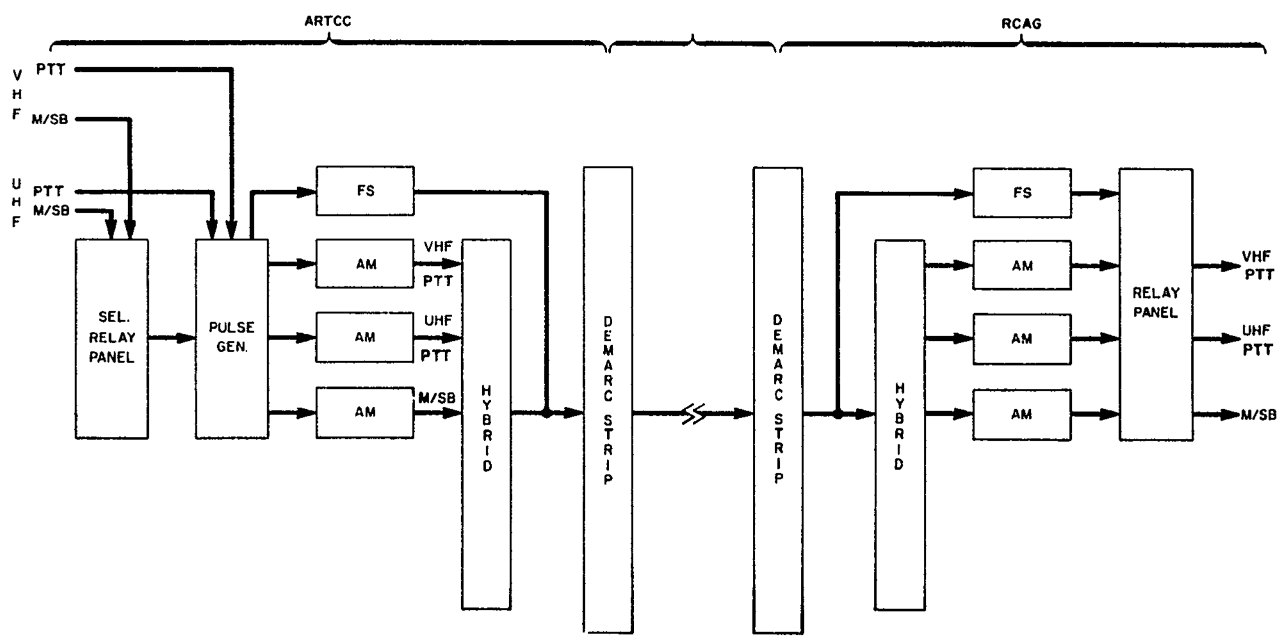

Figure 2-4. Selective-Channel Operation Block Diagram

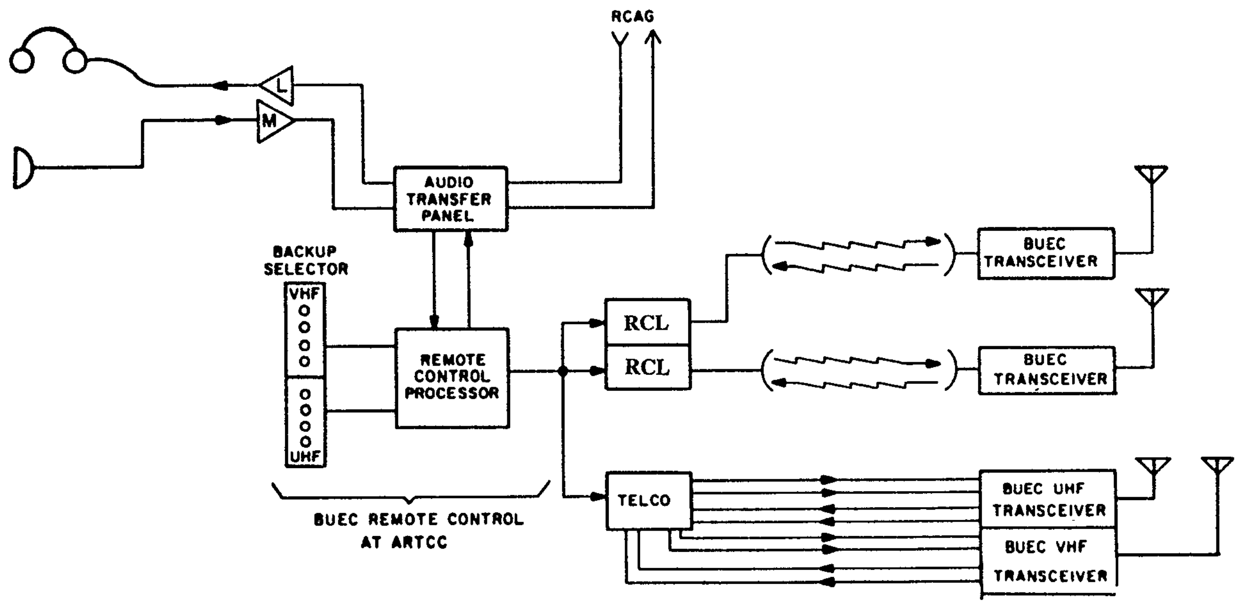

Figure 2-5. BUEC Subsystem Block Diagram

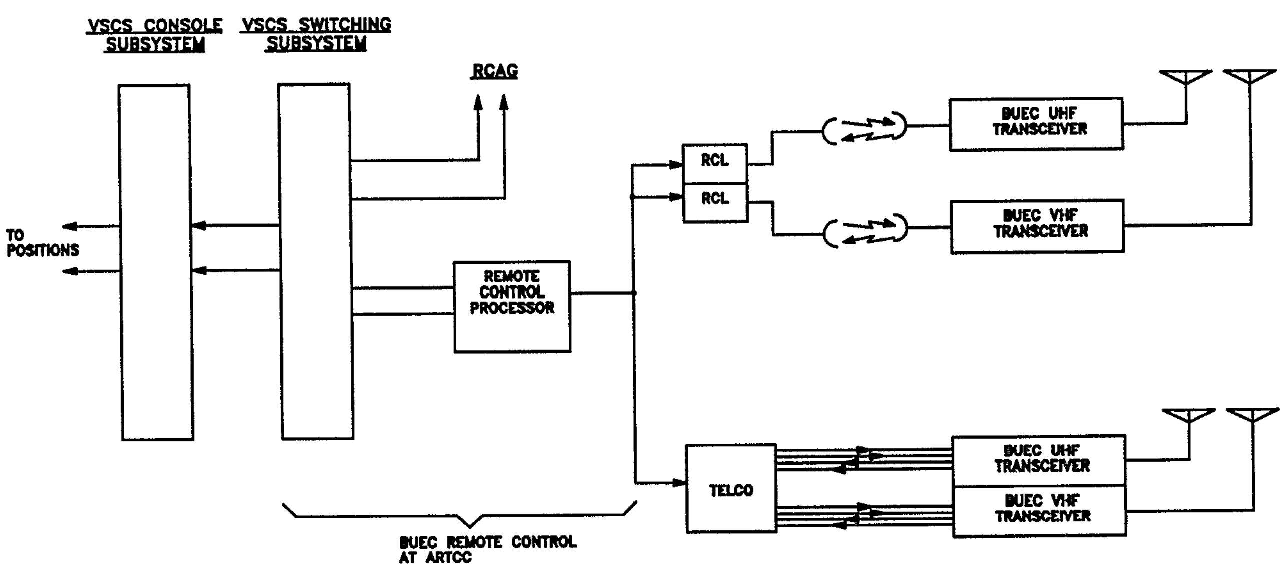

Figure 2-5A. BUEC Subsystem Block Diagram with the VSCS Interface

Section 1. DESCRIPTION OF EQUIPMENT

30. POSITION AND CHANNEL EQUIPMENT. The equipment that makes up the air route traffic control system may be usefully categorized into position equipment or channel equipment. Position equipment is defined as the interface or control point from which the controller makes use of the radio frequency or other communication channels available.

a. Receiving/Transmitting. Position equipment includes all ancillary equipment up to the position patch panel or main distribution frame. Channel equipment includes all equipment extending beyond the position patch panel. (See figure 2-6.)

(1) The receiving system consists of position equipment and channel equipment as shown in figure 2-7. The position equipment consists of the speaker and phone amplifiers, speaker, phones, and switching and level control equipment. The channel equipment consists of the receiver and the line amplifier.

(2) The transmitting system consists of position and channel equipment as shown in figure 2-8. The position equipment consists of the microphone, microphone amplifier, and transmitter control panels. The channel equipment consists of the transmitter control equipment and transmitter.

b. Four-Channel Control System. Four-channel control equipment is the FAA standard for a-g radio channel selection. The four-channel expandable equipment replaced the 10-channel and 15-channel equipment. One to five control units are generally installed at one position.

(1) The receiving four-channel control equipment is designed to permit the controller to select from one to four radio channels, using an individual selector panel installed at a position. The panels also provide a visual indication of the received signals with a neon lamp. An internal-wiring option permits the level control on one panel to be used as the master level control for a position when more than one panel is installed. Additional units will accommodate up to 20 channels at the position.

(a) At ARTCC's, the output of a receiver or line amplifier is wired to a step-up transformer. The step-up transformer increases the audio voltage enough to ionize the neon lamp on weak signals, and it also improves the power transfer to the receiver selector panel.

(b) Newer models of the receiving four-channel equipment are similar to the older models, but they have the output level control in a separate panel.

(2) The transmitting four-channel control equipment is a complete, expandable transmitter control system. One unit can accommodate four different radio channels. Additional units may be wired in parallel to provide up to 20 channels to a position. The control equipment incorporates features to permit selection of the same channel at several positions. A channel is selected by operating the channel selector key. The control system keys the transmitter, connects the audio to the transmitter, and mutes the receiver output. It also provides a busy-channel indication at adjacent positions. The load impedance on the amplifier varies less than 10 percent when a transmitter channel is keyed.

(a) The transmitting four-channel control equipment uses two power supplies: 48 V dc and 46 V ac. These power supplies are located in the equipment room. The 48 V dc power supply provides power for the relays in the control system, and the 46 V ac power supply provides power for the control indicator lights.

(b) The newer model four-channel transmitter control panels differ from the older model panels in that the interlock relays are in the panel located in the equipment room rather than in the switching panel. Some models have internal attenuators to permit adjustment of individual channel losses.

c. Console Equipment (Unit 2).

(1) The air traffic VSCS console equipment (VCE) includes all equipment from the controller position to the VSCS position intermediate distribution frame (IDF). See figure 2-6A.

(2) VSCS Display Module (VDM). The VDM, two per controller VCE, provides the display and data entry functions to support controller a-g and g-g requests and channel equipment status. The VDM consists of an interactive color video monitor with an infrared (ir) touch entry device (TED) mounted to the display area, monitor electronics for video, brightness/degaussing control, and fault status. The TED is the controllers interface for initiating communication paths between the console and the a-g and g-g channel equipment.

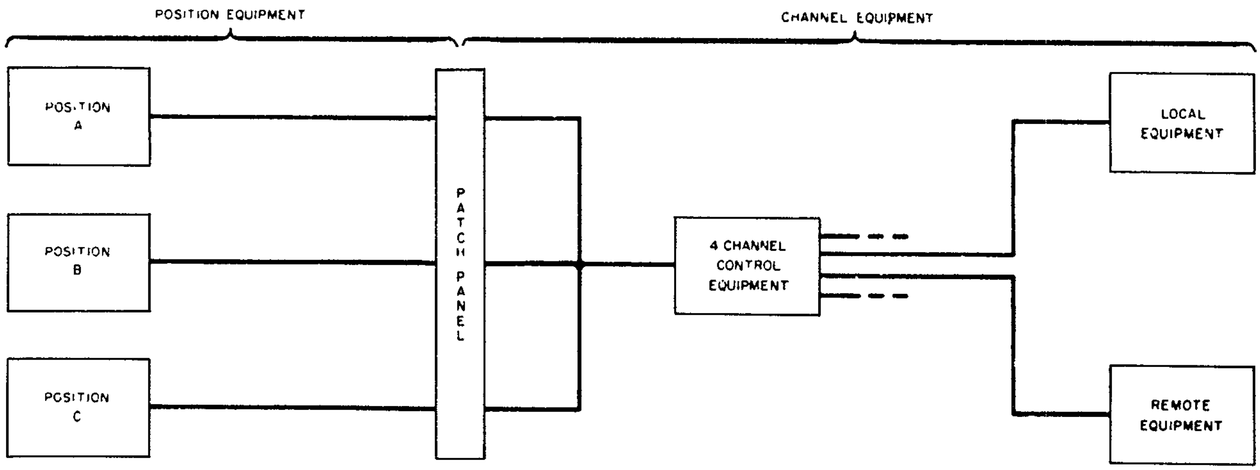

Figure 2-6. Basic Position and Channel Block Diagram

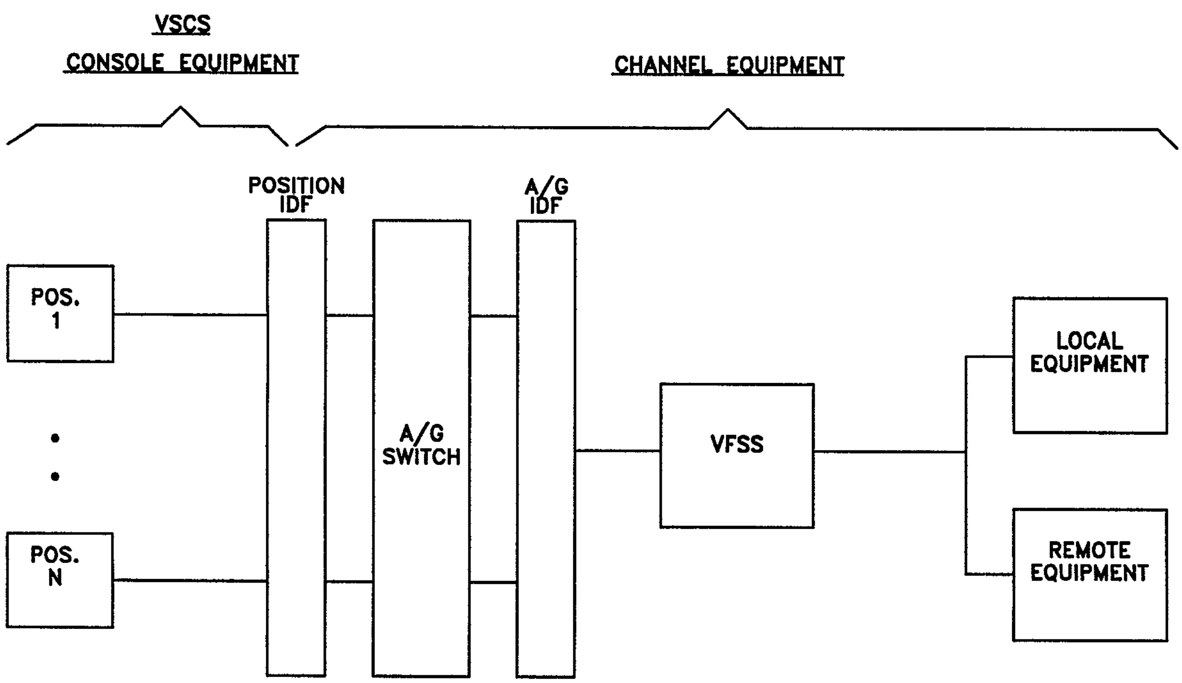

Figure 2-6A. VSCS Position and Channel Block Diagram

(3) VSCS Equipment Module (VEM). The VEM supports inputs, outputs, and processing of the VCE.

(a) VEM inputs include a-g and g-g voice signaling, command and configuration messages from the control subsystem, and peripheral inputs from the touch entry device, push-to-talk (ptt) switches; indirect access keyboard, and controller voice.

(b) VEM outputs include a-g and g-g digital voice plus signaling, position status messages to the control subsystem, VDM and keyboard display data, and controller headset and loudspeaker audio.

(c) VEM processing functions support the VCE software, physical interfaces, and built-in test (BIT) diagnostics.

(4) VSCS Indirect Access Keyboard (VIK). The VIK provides input to the VEM main card for dialing calls. The VIK includes a standard telephone-type 3- by 3- by 1 -inch illuminated numeric keypad with three function keys, an LED message display of two 16-character rows to display system messages, and operator inputs. The VIK has two modes: message mode for displaying system messages to the operator and digit collection mode, which allows the controller to enter an intercom/interphone number or special function number.

(5) Dual Jack Module (DIM). A DIM provides termination for two headset/handset (HS) six-wire, double plugs on 5/8-inch centers (referred to as HS Al and A2). Two parallel DJM' s are provided at each controller position and provide the total interface connection for four HS's. The DJM provides a presence signal to the VEM, which causes the VDM to brighten when an HS is inserted. At least one HS must be connected to activate the console position equipment. HS's Al and B 1 provide local ptt preemption capability over HS A2 and B2, respectively.

(6) G-G Loudspeaker (LS) Module. The module consists of an LS, LS volume control, two HS volume controls, chime on/off control, chime volume control, and a green light emitting diode (LED) chime status indicator. The speaker is designed to handle 5 watts of power. The impedance of the speaker is nominally 8 ohms. The speaker has nominal acoustic response of approximately 90 dB sound pressure level at 1 meter with 1 watt of drive power. The LS volume control has a resistance of 5 kilohms, a power rating of 2 watts, with a linear taper characteristic. All terminals of the device are cabled to the VCE controller and are isolated from ground. The control shaft is at chassis ground potential. The HS volume controls are the same as the LS volume controls. The HS volume controls provide -52 dBm to -20 dBm adjustment range.

(7) A-G Loudspeaker (LS) Module. The a-g LS module is the same as the g-g LS except there is no chime volume control, LED, or ON/OFF control. The module consists of an LS, LS volume control, and two HS volume controls for control of voice levels to a-g LS and HS Al and A2.

d. VEARS. VEARS position equipment consists of a single, dual, or quad module, multi-pair cables, and ancillary speakers. There is no software in the system. Each module is accessed through a separate identifiable jackbox located at the air traffic control console. The single module provides access to one frequency pair per sector. The dual module will accommodate dual diversity frequencies; a selector switch will allow interface of VEARS with either of two sites. The quad or four-channel module provides for multiple frequencies with independent access to satisfy coverage in large airspace sectors. The RCA/patch rack switches frequency access between VEARS and the VSCS.

(1) Single Module. The VEARS single module provides access to one frequency pair per sector. The module provides main/standby selection, an HS volume control, push-to-talk indicator, and an LS selector with ON indicator. Cable connections are made on the back of the unit. Activation of the module is accomplished when a headset or handset is plugged into the VEARS jackbox.

(2) Dual Module. A dual module provides access for dual diversity frequencies. The dual module has a selector switch that allows interface of the VEARS with either of two A/G channels. The dual module has independent main/standby selection, but the ptt and audio are dependent on the A/B selector switch. With the selector switch in the A position, ptt and headset audio are directed to the dedicated A position. The ptt for the other channel is cut off and receive audio is routed to a remote speaker. Activation of the dual module is similar to the single module.

(3) Quad Module. A quad or four channel module provides access for multiple frequencies with

independent access to satisfy coverage in large airspace sectors. The quad module has independent switches to select ptt, main/standby, and receive audio. The quad module has independent main/standby selection, but the ptt and audio are dependent on a selector switch for each frequency. A three position toggle switch for each frequency can route the audio to either the headset, a remote speaker or can be turned off. The TX/RX switch is used to select either transmit or receive for one or all of the four frequencies. Activation of the quad module is similar to the single module.

(4) Ancillary Speakers (LS). All VEARS modules have external amplified speakers. The speakers have been procured as an integral part of the VEARS system, and are wired directly to the VEARS audio. The speaker assembly consists of a four inch speaker, with a one watt amplifier attached directly to the speaker, and a volume control.

31. HEADSETS.

The FAA uses several types of headsets at centers. The headset may be either the older Model WE-52 or one of the lightweight models. The WE-52 has a carbon microphone with an output impedance of approximately 90 ohms. The others employ a dynamic transducer, and the output impedance is approximately 50 ohms. (See Order 6650.2B, Maintenance of Audio and Speech Equipment, for a description of headsets.)

32. WITHDRAWN -- CHG 6

33. AUDIO AMPLIFIERS.

Four basic types of audio amplifiers are installed in a-g facilities: regulated output, multichannel, multifunctional, and tone suppression. These amplifiers are designed for nearly flat frequency response characteristics over the audio range of 300 to 4000 Hz.

a. Regulated output amplifiers (ROA) are normally used as microphone amplifiers, at the ARTCC only, in transmitting circuits. The maximum rated gain of these amplifiers is 85 dB. An automatic gain control circuit

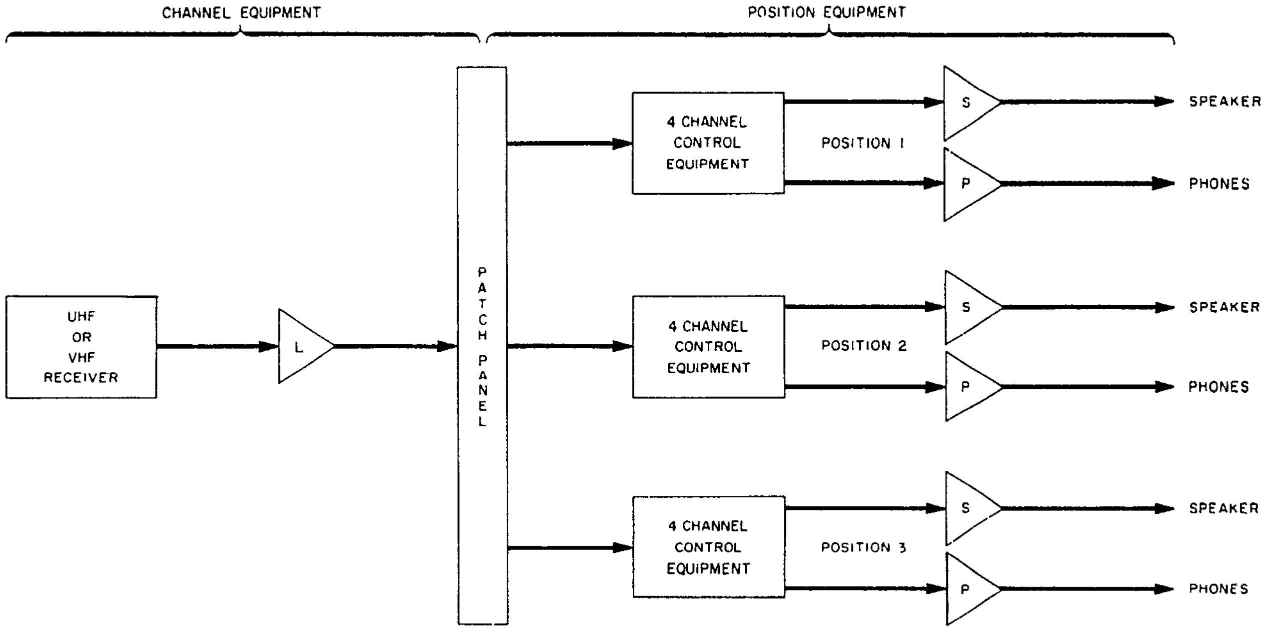

Figure 2-7. Basic Receiving System Block Diagram

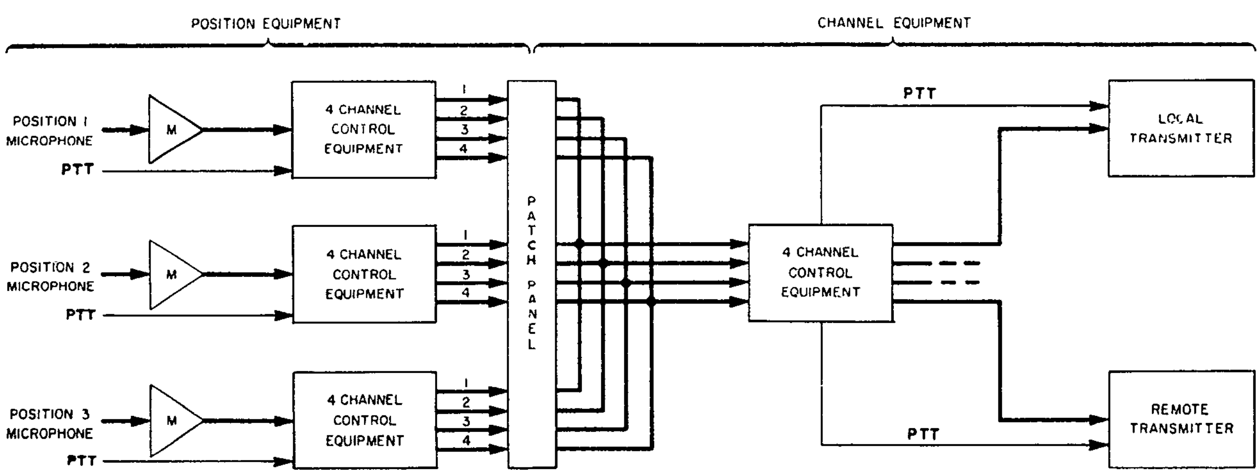

Figure 2-8. Basic Transmitting System Block Diagram

maintains a constant output level for a 40dB increase of input signal the output level may rise instantaneously up to 20dB before regulation occurs. The input impedance may be either 25 ohms or 600 ohms; the output impedance is 600 ohms.

b. Multichannel amplifiers include the following basic variations: (1) multiple input and output, (2) single input to multiple outputs, and (3) multiple inputs to single output. The first of these variations is generally used in a-g communication facility receiving systems. The second variation is used as part of a common microphone modulation system for several transmitting channels. The third variation is used as a mixing amplifier that combines signals from several sources for recording on a single recorder tape track.

c. Multifunction amplifiers are modular, solid-state assemblies of audio amplifiers that are designed to provide all the audio functions of a control position, e.g., line amplifier, mixing amplifiers, the microphone amplifier, and position phones and speaker amplifiers, through use of function-determining submodules.

d. Tone suppression amplifiers are experimental replacements for line amplifiers on the receive leg of RCAG channels. They are located at the ARTCC. Their purpose is to prevent sudden level increases and extraneous single-frequency signals, such as test tones, from reaching the controller at a level higher than the desired aircraft speech signal.

34. AUDIO AND CONTROL CIRCUITS.

The FAA has two categories of audio and control circuits: leased and FAA-owned.

a. Leased circuits are obtained through the Defense Commercial Communications office (DECCO) currently located at Scott Air Force Base. These circuits are owned by independent telephone and telegraph companies. Normally, circuits terminated beyond airport or FAA property boundaries are leased through Decco. The usual types of a-g communications control circuits are FAA-S-1142a circuits for tone control and 2002/3002 voice-grade circuits for such purposes as BUEC and intercenter data. The lease contracts specify the different performance criteria applicable to these circuits.

* **a-1.** Zero loss lines are nonconditioned basic 2-point, dedicated, voice-grade telco circuits where the higher transmission quality of other access services is not required. Zero loss lines are characterized by a standard loss of 0 dB at 1000 hertz and have a nominal frequency range of 300 to 3000 Hz. The FAA specifies that the lines exhibit an impedance of 600 ohms. Standards and tolerances and periodic maintenance routines for voice-grade lines may be found in Order 6000.22, Maintenance of Analog Lines. *

* **b. F**AA-owned circuits are usually cables buried within the facility grounds. Performance requirements for these cables depend upon specific utilization.

c. Alternate or redundant routed audio and control circuits are also leased from telco and, upon failure of the primary leased circuit, are either manually or automatically transferred to the facility channel. The alternate circuit is tied between ARTCC and RCAG but is distinguished by its entirely different route as compared to the route of the primary circuit. The redundant circuit is also tied between ARTCC and RCAG and is a spare line of carrier equipment as does the primary circuit. The length of the alternate circuit is usually longer than that of the primary; the length of the redundant type is normally the same as that of the primary circuit. Much greater protection from outages is logically provided by the alternate route than is obtainable from the redundant route. Either type of circuit can be transferred by the switching system -1 (SS-1). Maintenance of the SS-1 is a responsibility of telco. A description of the SS-1 and its performance requirements is contained in Order 6000.22, Maintenance of Analog Lines. *

d. Another kind of telco switching equipment currently installed at RCAG's does not involve transfer of spare lines. This is the loopback (or looparound) equipment FAA or telco-actuated at the ARTCC. Its purpose is to provide a qualitative check of the transmitting and receiving telco circuit of the same channel by enabling the FAA technician to perform a continuity test with a test tone. The loopback equipment is telco-maintained.

35. TRANSMITTERS.

A-g communication transmitters installed by the FAA for en route domestic service operate either vhf or uhf bands. The transmitters are designed for double-sideband (dsb) amplitude modulation (am) with power outputs ranging from 10 to 50 watts (W). The 10- and 50W transmitters are used for a-g communications service in the vhf/uhf band. All transmitters are crystal controlled, either single channel or multichannel. The nominal modulator circuit audio frequency response is 200 to 3000 Hz ±1.5dB with an audio input range of -l5dBm to + 10dBm. (See Order 6580.5, Maintenance of Remote Communication Facility (RCF) Equipment.)

36. TRANSMISSION LINES.

All vhf and uhf a-g communications systems use 50-ohm coaxial cable for interconnection of the antenna and the transmitting or receiving equipment. (See appendix 8 of Order 6580.5 for descriptive data on cables and connectors.)

37. ANTENNAS.

The vhf and uhf antennas used for a-g communication systems are of several different types, depending upon

AT operational requirements and frequency band. They are designed to match 50-ohm transmission lines, and they are usually of the vertically polarized, omnidirectional type for signal reception and of the circularly polarized, omnidirectional type for signal transmission. (See Order 6580.5 for antenna descriptions and maintenance requirements.)

38. RECEIVERS.

The receivers used in the domestic en route a-g communications system utilize the vhf and uhf frequency ranges. Typical features include noise limiters, automatic volume control (avc), automatic gain control (agc), and carrier-operated squelch. Vhf and uhf receivers are designed with 50-ohm input, providing a suitable match for coaxial cable. The receiver output impedance is either 600 ohms or 20,000 ohms. (See Order 6580.5 for descriptive information and maintenance requirements.)

39. SPEAKERS.

The Jensen AP-10 speaker is used at most facilities. This speaker is designed to handle up to 5W of power; however, the normal listening level power is close to 250mW. Most facilities have a transformer matching the 3.2-ohm voice coil to a 600-ohm line mounted in the speaker case.

40. BACKUP EMERGENCY EQUIPMENT.

a. Solid-State Transmitters and Receivers. Fixed-tuned transmitters and receivers covered by Order 6580.5 are permanently set up on the emergency guard frequencies 121.5 and 243.0MHz. This equipment is termed the "local" transmitter and "local" receiver in chapters 3, 4, and 5 of this order.

b. BUEC Subsystem (Old Configuration). A complete subsystem with its own control and intersite link, called the "backup emergency communication" facility, is available at all ARTCC's in addition to the "local" transmitters and receivers. Unlike the local equipment
* that is limited to two frequencies, the BUEC configuration can be quickly tuned to any air traffic control frequency allocated to the center including the two emergency guard frequencies. This system is comprised of an ITT remote control group and ITT 20 W transceivers.

c. BUEC Subsystem (New Configuration). This system is also a complete subsystem with its own control and intersite link. This configuration is comprised of Motorola fixed tuned CM-200 transmitters and receivers and CSTI CS-2330 radio control equipment. This configuration is the replacement system for the old configuration using the ITT transceivers. *

41. TELEPHONE SWITCHING SYSTEMS.

Several telephone switching systems have been designed to meet the unique requirements for air traffic control service and leased to the FAA. Of these, the 300 switching system (300SS) is currently used at ARTCC's. The 300SS provides communication (1) among the controllers within an individual ARTCC, (2) among ARTCC's, and (3) between ARTCC's and other FAA, military, or civil facilities. The system provides rapid signaling and voice communication by common control equipment, signaling system SS-1, and a crossbar switch field. It will accommodate many positions and many lines. The system also provides access to the FAA radio channels at the controller's position. (See figure 2-9 for a simplified, functional diagram of the 300SS showing one supervisory and two controller positions.)

a. Principal 300SS Features. The most important features of the 300SS are:

(1) Direct access (DA) of AT controller to a number of most-wanted lines, other positions, or a-g radio channels by operation of a key (one per line),

(2) Indirect access (IA) for AT controller to any position or line available to the ARTCC by operation of a pushbutton dial,

(3) Visual indication at a specific position in the ARTCC of incoming interphone calls intended for that position,

(4) Arrangements enabling an AT controller to have calls that are directed to his/her position transferred to another position,

(5) Monitoring of a second position by one position (e.g., the coordinator) without the knowledge of the second position,

(6) Simultaneous transmission capability on radio and a preselected interphone line at a position,

(7) Capability for an exchange of position control, whereby the controller can operate the position without exchange of telephone instruments or jacks,

(8) Circuit arrangements to permit establishment of connections over dial, manual, or selective signaling lines or connections to a-g radio facilities either singly or in combination,

(9) Incoming dial selection of control positions with call storage and sequence answering and with primary and secondary answering responsibility arrangements on certain lines.

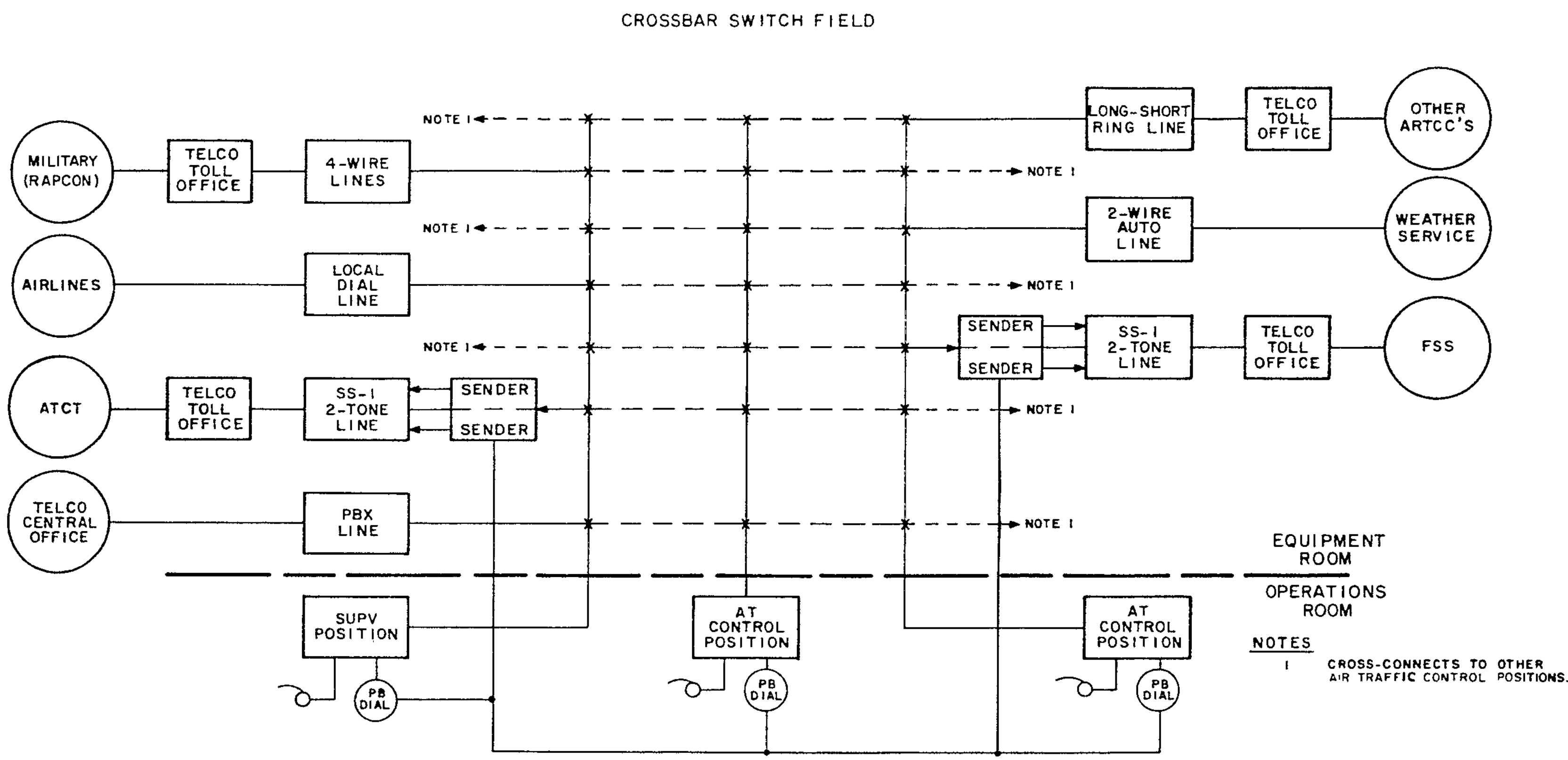

Figure 2-9. 300SS Simplified Functional Diagram

* (10) Position intercommunication on an override basis so that one position always has access to another, even though it may be busy. *

(11) Distinctive types of lamp indications, such as steady, flashing, fluttering, or winking, at positions to indicate the status of a line or call,

(12) Individual position blanking of lamp displays to eliminate any unnecessary flashing or steady lamp displays,

(13) Provisions for using the position telephone set with FAA-provided radio equipment on an automatic transfer basis, e.g., between interphone lines and radio channels,

(14) Audible guard tone signal on dial lines while dialing is in progress,

(15) Arrangements to permit simultaneous origination and termination of multiple line and position connections, and

(16) Rapid service connections via pushbutton dialing.

b. 300SS A-G System. A brief description of the circuits of the 300SS a-g system follows.

(1) Radio Control Line (RCL) Circuit. The RCL circuit interconnects the FAA radio equipment with the telco channel selection and position equipment. Some of its functions are to maintain transmission levels on a radio channel when several positions are combined; to allow, by means of a lockout, only the controller exercising push-to-talk control to have access to the circuit; to indicate by lamp that a speaker is in use; and to block sidetone signals to the speaker.

(2) Position Equipment.

(a) Pushbutton (ph) Dial. The ph dial is a set of nonlocking pushbutton keys at a position to take the place of the rotary dial. It is equipped with START, END, and CLEAR control buttons, a READY lamp, and 10 code buttons labeled in the same way as the conventional rotary dial.

(b) Primary and Secondary Answering and Key Displays. Each set consists of four lamps and a key. The lamps indicate incoming calls. When the key is depressed, one lamp indicates that the position has answered a call.

(c) Lamp Displays.

1 Available Line — lamp is dark or backlighted

2 Line Busy at Another Position — lamp illuminated (steady)

3 Unanswered Incoming Call — lamp illuminated (flashing: 60 per minute)

4 FAA Equipment or PBX Lines on Hold — lamp illuminated (winking: 120 per minute)

5 Indicates Line or Feature to Which Connected — lamp illuminated (fluttering: 720 per minute)

6 Proceed with Dialing — red ph dial ready lamp illuminated (steady)

7 Proceed with Dialing — red ph dial ready lamp illuminated (flashing to indicate invalid dial code used)

8 Another Position Has Joined — green position override lamp illuminated (steady)

9 No Unanswered Calls Directed to the Position — red position pilot lamp dark

10 Unanswered Call Directed to the Position — red position pilot lamp illuminated (flashing)

(d) Position Jacks and Radio Transfer. Three basic sets of jacks are provided for the controller's position; other sets may be multiplied to provide additional access for other personnel (training, supervision, and coordination). The principal sets of headset jacks are:

1 D Jacks (Black). These are telephone jacks to permit a controller to connect his/her headset to wire lines (interphone) only.

2 R Jacks (Red). The R jacks permit connecting the headset to radio lines only. (These are not part of 300SS for purposes of maintenance.)

3 A Jacks (Yellow). The A jacks permit connecting the headset to either interphone or radio lines. A controller using these jacks is continuously connected to the radio channels associated with this position. Because the jacks have interphone capability, the operation of a line position key causes a disconnection of the radio line from the controller's headset and automatically transfers it to the 300SS loudspeaker. If a controller at the position is using the R jacks, a controller at the same position cannot access the A jacks radio connection. Removal of the headset from the R jacks automatically connects the FAA

loudspeaker to the radio circuit, but only if the headset is selected at the selector panel.

(e) Conferencing Circuits. A maximum of 15 positions may join in a conference hookup. The conference line circuit connects by way of toll telephone facilities to coordinator and position circuits at other 300SS locations.

42. RADIO HEADSET PANEL.

The radio headset panel (rhp) provides the means for the air traffic controller to use telco headsets with the FAA radio communications circuits. When installed in conjunction with the 300SS, it allows the controller to use the R or A jack on the FAA radio circuit. The panel was designed in collaboration with Bell Telephone Laboratories to duplicate the frequency response and signal levels of the 300SS.

a. The receive audio signal is supplied to the panel from the output of the position amplifier. A pad attenuates the audio to only the FAA radio (red) jack. The audio to the telco radio/interphone (yellow) jack is attenuated by another pad and is connected to the input of the 300SS through the "option X" relay (untransferred). The option X feature automatically transfers the receiver audio to the input of the FAA position speaker amplifier when the controller removes his/her headset plug from the yellow jack or selects a landline (interphone). The level of the signal to the input of the position amplifier may be set by adjusting an attenuator.

b. The transmit audio signal from either the telco or FAA microphone is connected to the input of the position amplifier by the transfer contacts of a relay. The operation of this relay is interlocked with the ptt circuit of the FAA or telco headset so that the operator who first keys the circuit will control the circuit. Power for the operation of relays and the FAA microphone circuit is supplied by the ARTCC central 48V dc supply.

c. The audio signal for position recording is obtained at the output of the FAA headset jack (or from the telco demarc) and is a combination of both the receive and transmit audio signals. The signals are combined by connecting the output of the position regulated output amplifier to the input of the position phones amplifier through the sidetone network. The sidetone network attenuates the audio signal and provides an adjustment for setting the signal level to the phone amplifier.

d. There are several models of the radio headset panel (rhp) in the field. The identification numbers of the rhp units to be found at the various facilities are: FA-5398, FA-5552, FA-7885, FA-8123, FA-8196, and FA-8196A. All are now made identical by three circuit standardization modifications.

43. RECORDERS.

Multichannel tape recorders, installed at FAA facilities, record all air traffic control information. This tape recording is used as a legal record and also provides information for training AT personnel. The recorders have dual tape transports and standby power supplies. They can record up to 152 channels, depending upon the model, and have a frequency response that is essentially flat, from 300 to 2700Hz. (One channel of each recorder is allocated for recording time.) All recorders incorporate features to provide automatic transport and power supply changeover. Inputs for the recorders are taken from the 300SS and FAA radio channels. The various signals are combined by means of mixing amplifiers and then fed to the recorder. Air Traffic Service policy is to record only the information heard and spoken by the controller, except that time is continually recorded on its own channel. The electronic and mechanical details of multichannel recorders are available in their instruction books. Maintenance requirements are in Order 6670.4A, Maintenance of Multichannel Recorder Equipment. Tape handling and storage instructions (a maintenance responsibility) are in Orders 6670.4A and Order 6670.1A, Multi-Channel Recorder Check Record, FAA Form 6670-1.

44. TEST POSITION.

The test position includes the same basic equipment associated with a controller's position and is wired to be similar to that of the controller's position. When the test position is patched in, maintenance personnel can simulate all the functions of the controller's position. This test position may be mounted in a rack or on a cart and may be found at some ARTCC's.

45. TELECOMMUNICATIONS EQUIPMENT AND CIRCUITS.

Telecommunications circuits transmit information over landlines. This information consists of weather reports, Notice to Airmen (NOTAM's), and administrative traffic of the agency. High-speed circuits consist of the automated Service "B" Data Interchange System (A-BDIS), operating at 1,071 words per minute (wpm). The low-speed teleprinter circuit operates at 100 wpm. Communications security (COMSEC) terminals, connecting the military automatic digital network (AUTODIN), are at each ARTCC. These terminals use KW-26/Mode V or KG-13/Mode V terminal equipment.

Airway Facilities maintenance personnel are responsible for maintaining the installed A-BDIS, COMSEC, and teleprinter equipment. Leased maintenance is provided for certain interface equipment, such as the COMSEC Mode V. The teletypewriter and switching equipment maintenance handbook is Order 6170.6A, Maintenance of Data-Handling Terminal Equipment (Teletypewriter). COMSEC maintenance is prescribed in Order 6170.7 (confidential), Installation and Maintenance of COMSEC Equipment.

46. VOICE-FREQUENCY SIGNALING SYSTEM (VFSS).

The VFSS provides the capability to control equipment at a remote facility and permits voice communications over the same circuit. The system operates in the voice-frequency (vf) range over an FAA-S-1142a telco circuit. The VFSS consists of send terminal equipment at the ARTCC and receive terminal equipment at the RCAG. The send terminal equipment transmits discrete audio tones, which permit control of several switching circuits at the receive terminal. The switching circuits key transmitters, control receivers, and transfer equipment and permit status monitoring of remote facilities. Several models of the VFSS, including solid-state models, and the newer digital type are installed at the ARTCC's. All, however, have essentially the same control capacity and technical characteristics. The tube models in the field are the CA-1621, CA-1708, and FA-5390. Solid-state models include the FA-8187 and FA-8735. The digital type is the LCT-CNTR-1A/RTC-RCAG-1A System. (Refer to Order 6650.4B, Maintenance of Voice-Frequency Signaling System (VFSS) Equipment, for all maintenance information on VFSS equipment associated with en route communication channels.)

47. POSITION PATCH PANEL.

The position patch panel allows the radio channels at a controller's position to be changed at will without rewiring. This is done when AT needs to "resector." The patch panel permits the receive audio, transmit audio, transmitter keying, interlock, and indicator circuits of a channel to be patched into any desired position. A test position may also be patched into the channel for maintenance purposes. Various kinds of patch panels with matching jacks, plugs, and cords are in use. Some centers have installed computer-type program boards; others employ the older Jones plugs and receptacles in resectoring, or position patching arrangements.

48. RADIO LINKS.

a. Vhf Links. Vhf link communications are installed by the FAA in areas where telephone lines are unavailable or uneconomical. They provide circuits for communication and control between the ARTCC and its remote facilities. The vhf link uses a frequency-modulated (fin) vhf carrier. Repeater stations are installed when distance or terrain makes the operation of the basic system impossible. (Refer to Order 6540.3B, Maintenance of Communication Link Systems, for a description and maintenance requirements for these links.)

b. Microwave Links. Microwave links are installed in some areas to furnish the circuits for communication and control between the ARTCC and its remote facilities. Some microwave links are used primarily to relay radar and beacon data and control information between the ARTCC and the radar site; others will carry data, controls, and BUEC transmissions. The RML maintenance requirements are Orders 6350.13A, Maintenance of Radar Microwave Link Equipment -1A, -2, -3, and -4; and 6350.15C

49. MASTER DEMARCATION SYSTEM (MDS).

The MDS is the physical point of separation between communications systems that leave the ARTCC (telco, RCL) and user equipment located within the ARTCC and for most circuits designated as the 0 transmission level point (0 TLP). It consists of wiring frames and jackfields designed to provide a centralized location for circuit patching, circuit testing, and trouble isolation. Normal operating signal, levels at the MDS (0 TLP) should not exceed -13-dBm average over a 3-second interval. Telco circuits at the MDS should be established as the end-state configuration of zero loss lines.

Section 2. SYSTEM OPERATION

50. TRANSMITTING SYSTEM-SPLIT CHANNEL.

a. ARTCC Equipment. The ARTCC equipment for split-channel operation is shown in figure 2-10. Since all channels operate similarly, only one will be explained.

(1) Telco circuits are used to carry speech signals, to key the transmitters, and to select the main or standby transmitting and receiving equipment at the RCAG.

(a) The controller keys the remote or local transmitter by operating the channel selector switch(es) on the transmitter control panel and closing the ptt switch. This completes a circuit through the radio headset panel and transmitter controller equipment to the pulse generator of the VFSS equipment. The pulse generator keys the frequency-shift (fs) and amplitude-modulated (am) senders, which generate discrete audio tones to operate the VFSS equipment at the RCAG.

(b) The controller transfers the remote transmitter and receiver equipment from main to standby by

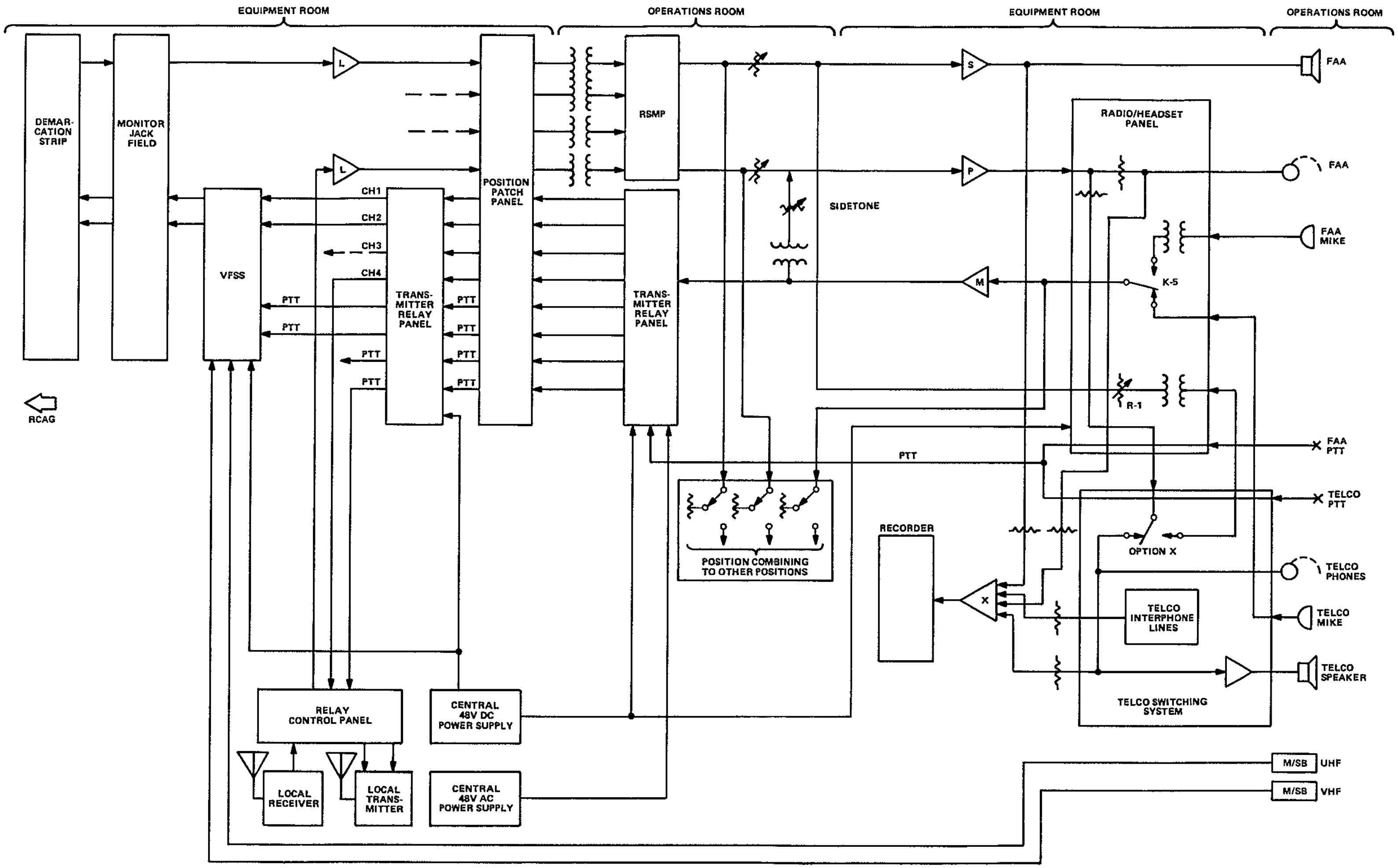

Figure 2-10. ARTCC Channel and Control Diagram

operating the position main/standby selector switch. The main/standby selector switch energizes the pulse generator. The pulse generator keys the fs and am senders, which transmit discrete tones to the RCAG to operate the main/standby functions.

NOTE: In addition to tone-channeling equipment, remote equipment is also keyed or controlled using in-band tone signaling over leased voice-grade lines. This 2600Hz on-off tone, provided by the serving company, is filtered out of the voice band. Other keying or control may be achieved over direct-current (do) simplexed circuits that are described in Order 6650.5, Maintenance of Electrically Operated Remote Control Equipment.

(2) The audio signal from the controller's microphone is connected through the headset panel to the microphone amplifier. It then passes through the transmitter control equipment and the VFSS before it is applied to the RCAG telco line.

b. Telco Circuits. The telco circuit between the ARTCC and the RCAG is normally a four-wire circuit. A few two-wire circuits are still in use. Because of operating flexibility, four-wire circuits predominate. Four-wire circuits are also immune to hybrid problems inherent in two-wire systems.

c. RCAG Equipment. A typical RCAG is shown in figure 2-11.

(1) All equipment control functions at the RCAG are normally performed by the VFSS. The fs and am receivers energize certain relays when tones of a discrete frequency are received from the ARTCC. Each time a function is selected, the fs tone from the ARTCC shifts from mark to space. The space signal energizes the fs receiver switching circuits to remove a short from the input of the am receivers. If the keying function has been selected, the am tone from the ARTCC energizes the am receiver and its switching circuits to key the transmitter. If a main/standby function has been selected, the am tone transmitted by the ARTCC is pulsed to operate a stepping switch connected to the am receiver. The stepping switch operates in relation to the number of pulses transmitted to select the desired main/standby transfer function.

(2) The audio signal from the telco line is connected to the input of the line amplifier and then to the input of the transmitters through contacts on the main/ standby relay.

51. RECEIVING SYSTEM—SPLIT CHANNEL.

a. RCAG Equipment. A typical RCAG is shown in figure 2-11. Since all channels operate similarly, only one will be explained.

(1)Control circuits transfer the telco line to the standby receiver when the main/standby function is selected.

(2)The audio signal from the receiver output is connected through a pad to the main/standby receiver transfer relay, and an attenuator is connected to the telco line.

b. Telco Circuits. The telco circuits from the RCAG to the ARTCC are voice-grade circuits, normally terminated as four-wire circuits at either terminal.

c. ARTCC Equipment. Figure 2-10 is a simplified channel and control block diagram of the ARTCC equipment wired for four-wire operation.

(1) The operator's controls for the receiving channels are the four-channel selector keys and headset and speaker volume controls located at the controller's position.

(2) The audio signal from the RCAG telco circuits connects through a line amplifier and a step-up transformer to the input of the receiver selecting and mixing panel (rsmp). When an aircraft signal is received from the RCAG, a neon lamp on the rsmp glows to indicate the active channel to the controller. The controller operates the channel selector switch on the rsmp to either the phones or speaker position. If the speaker position is selected, the receiver audio signal at the output of the rsmp is directly amplified by the position speaker amplifier, which drives the position FAA speaker. A series resistor located in the radio headset panel (rhs) provides isolation between the rsmp speaker output circuit and the position speaker amplifier input. This reduces the shunting effect of the rsmp speaker volume control when the control is in the minimum resistance position. When the phone position is selected, the audio from the output of the rsmp is amplified by the position phone amplifier. The output of the position phone amplifier feeds the input of the radio headset panel (rhp). The rhp interconnects the FAA red jack, the telco yellow jack, and the FAA position recorder.

(a) If the controller's headset is plugged into the

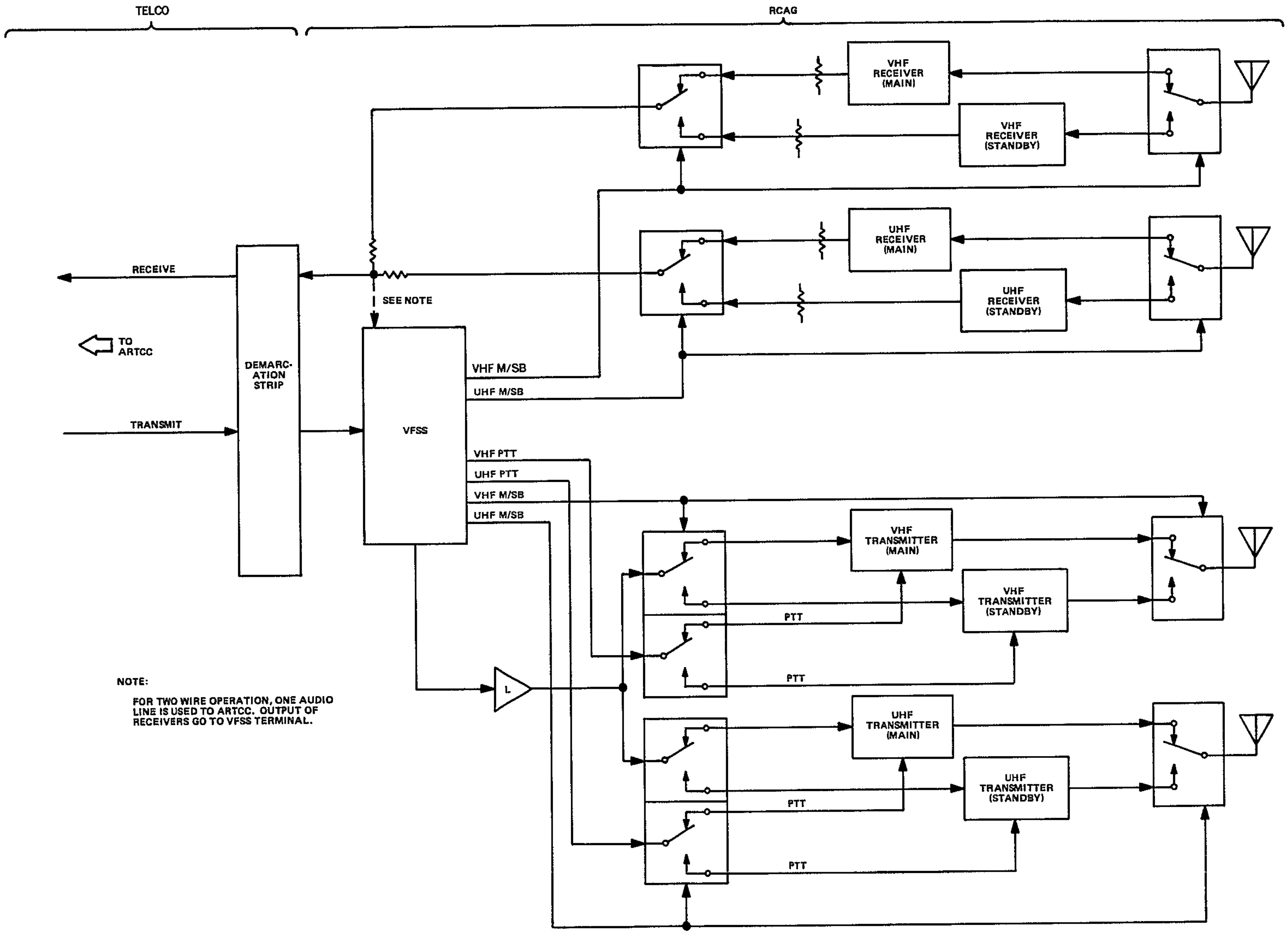

Figure 2-11. RCAG Channel and Control Diagram

FAA red jack, the signal is heard in the headset earphone and is recorded on the radio position recorder channel.

(b) If the headset is plugged into the yellow jack, the signal is heard in the headset earphone and is also recorded on the telco position recorder channel.

(c) If the headset is not plugged into either jack, a radio transfer circuit connects the receiver audio signal to the input of the position speaker amplifier. The signal is then heard in the FAA position speaker and is recorded on the radio position channel.

NOTE: The FAA radio (red) and telco (yellow) controller position jacks have been discussed in subparagraphs (a) and (b) for the received signal path. Other jacks are to be found at controller positions and used for various air traffic control requirements, such as coordination, supervision, and training. Also, a G-5 handset (in addition to headsets) may be available for interphone operation. (Because of its high output level, the handset should not be used in radio jacks.)

52. TRANSMITTING SYSTEM—SELECTIVE CHANNEL.

a. ARTCC Equipment. Selective-channel operation uses a single VFSS to perform either the uhf or vhf channel selection. Refer to figure 2-10 for a simplified block diagram of the ARTCC. Since all channels operate similarly, only one will be explained.

(1) Position control equipment is used by the controller to key the remote transmitters and to select the main or standby transmitting and receiving equipment and to mute the receiving circuit. The transmitter keying function is the same as split-channel operation except for the VFSS. For selective channel operation, the keying circuits of the vhf and uhf transmitter control equipment are wired to key a single frequency shift (fs) sender and two audio mode amplitude modulation (am) senders of the same vf signaling equipment. One am sender transmits a discrete audio tone to key the remote uhf transmitter. Both transmitters are keyed simultaneously only if both are selected before the controller operates the ptt switch. The main/standby function operates the same for both selective and split-channel operation.

(2) The audio circuits are the same as those for split-channel operation. Refer to paragraph 50a(2).

b. Telco Circuits. The telco circuits from ARTCC to the RCAG are voice-grade circuits, normally terminated in four-wire configurations.

c. RCAG Equipment. A typical RCAG is shown in figure 2-11.

(1) All radio equipment at the RCAG is remotely controlled by the VFSS. When a single channel is selected, the fs receiver and an am receiver energize appropriate relays, thereby keying the selected transmitter. If both a vhf and a uhf transmitter are selected, the fs tone and two am tones are transmitted from the ARTCC to operate the fs receiver and two am receivers, thus keying both transmitters simultaneously.

(2) The audio circuits are wired the same as for split-channel operation (paragraph 51a).

53. RECEIVING SYSTEM—SELECTIVE CHANNEL.

a. RCAG Equipment. A typical RCAG is shown in figure 2-11. The audio circuits are wired the same as in split-channel operation and are discussed in paragraph 51a.

b. Telco Circuits. The control circuits from the RCAG to the ARTCC are leased as voice-grade circuits because they carry no control tones.

c. ARTCC Equipment. The ARTCC equipment is interconnected in the same manner as for split-channel operation. This type of operation is discussed in paragraph Sic.

54. TRANSMITTING SYSTEM—EMERGENCY. Transmitting equipment is usually installed in the ARTCC equipment room for the emergency communication channels of 121.5 and 243.0MHz. Refer to the ARTCC block diagram (figure 2-10).

a. Control Circuits. Position control equipment is used by the controller to key and to select the main or standby local transmitter. The operator keys a transmitter by operating a channel selector switch (on the transmitter control panel) and the ptt switch. This energizes the keying circuit through the radio headset panel, the transmitter control equipment, and the relay control panel. The controller can transfer the vhf and uhf transmitters from main to standby by operating the standby selector switch normally located at the position. The standby selector switch completes a circuit to the relay control panel to transfer the transmitter keying circuit and operate the antenna changeover relay.

b. Audio Circuits. The audio signal from the controller's microphone is connected through the headset panel to the microphone amplifier, the transmitter control equipment, and the relay control panel. The relay control panel switching circuits connect the audio signal to the selected transmitter through the main/standby transfer switch.

55. RECEIVING SYSTEM—EMERGENCY.

Receiving equipment is installed in the ARTCC equipment room for the emergency communication channels of 121.5 and 243.0 MHz. Refer to the ARTCC block diagram (figure 2-10).

a. Control Circuits. Position control equipment is used to transfer the uhf and vhf receivers from main to standby. The main/standby selector switch energizes switching circuits in the relay control panel. These circuits transfer the receiver audio output connections and operate the antenna changeover relay.

b. Audio Circuits. The receiver audio output is connected through switching circuits in the relay control panel, through the line amplifier and a step-in transformer, to the input of the rsmp. The signal path from the output of the rsmp is discussed in paragraph 51c(2).

56. RECORDING SYSTEM.

Air traffic control (ATC) information is recorded on magnetic tape recorders as a legal record and for training and evaluation of controller personnel. The information received and transmitted from each position is recorded on one or more recorded channels. Recording is achieved from various input sources as shown in figure 2-12.

a. Mixing Equipment. The audio signals from the FAA phones and FAA speaker coil are each fed to separate channels of a mixer amplifier through input attenuators. Another mixing amplifier receives signals from telco phones and telco speaker through the input attenuators of separate mixer channels. The 300SS inter-phone and telco phone circuits are mixed within the 300SS and are delivered as a single signal to an FAA mixer input. Mixer amplifier input impedances are relatively high (6000 ohms) so as to reduce the effect of loading on the input circuits. The mixing amplifier electronically combines the separate inputs into a single standard-level output signal applied to one track of the multichannel recorder. The mixer output impedance is 600 ohms. Each mixer input channel has an adjustable level control to accommodate various audio Input levels and yet provide a standard mixer output level to a recorder amplifier.

b. Recorders. Multichannel magnetic tape 152-channel high-capacity voice recorders (hcvr) are installed in ARTCC facilities. The recorder monitors tape break, tape motion, and power supply/bias oscillator. Failure of a monitored function causes the automatic transfer to the standby tape transport and/or power supply/bias oscillator and the conditioning of an external alarm indication circuit. (Sec Order 6670.4D.)

c. Alarm. Local and remote alarm panels are used to provide aural and visual indication of recorded failure.

57. CENTRAL POWER SUPPLY.

a. Power Supplies, 48 V DC and 46 V AC. Central 48 V dc power supplies are used at ARTCC facilities to power relay, alarm, and microphone circuits. Central 46 V ac power supplies are used for the panel indicator lamps. Main and standby power supplies are provided for each voltage. Although a manually operated transfer switch may be used, normally an automatic transfer unit switches the main or standby power supplies to the load. Both types of transfer units sound an audible alarm when a power supply fails. The new four-channel transmitter control equipment has a two-stage indicator lamp. It has 23 V ac on it in the unkeyed state and 46 V ac on it when the transmitter is keyed.

b. Fusing. Master fuse panels provide fused protection for each 46 V ac and 48 V dc branch circuit. Each branch circuit is monitored for fuse failure by a visual-indicating fuse. An aural alarm feature is also found at most ARTCC facilities.

58. AIR-TO-GROUND CHANNEL SCHEMATIC DIAGRAM.

The speech circuits of the air-to-ground communication channel use the audio components discussed in the preceding paragraphs. Their typical interconnection is illustrated by the simplified schematic diagram of figure 2-13. This illustration will be a useful reference when audio measurements in either voltage or power are made. The radio headset panel pads are shown recently standardized by an official modification plan. There will be differences between ARTCC facilities in the arrangements of this diagram.

59. FREQUENCY SELECTION.

Frequency selections are a single-touch action made from either VCE VDM's touch screens. When an unselected frequency button is touched, it becomes a frequency button group, comprised of three separate buttons. In addition to the information that the unselected buttons indicate, frequency button groups indicate transmitter/ receiver and communications status.

NOTE: Many of the changes an operator at one position makes to a frequency/site will impact operations and status of that same assigned frequency at other positions. These changes then will cause status changes to occur at other positions. The following status and control indications appear at all affected positions: enable/disable BUEC, enable/disable remote muting, enable/disable cross-couple, main/standby selection, site selection, ptt confirmed, diversity enable/disable.

a. Console Equipment. The controller selects assigned frequency for a transmitter and receiver by touching anywhere within the unselected frequency button. The unselected frequency button divides into a selected frequency button group. Three selectable buttons with separators and a frequency designator compose the selected frequency button group.

(1) The VDM touch entry device (TED) detects breaks in sets of x and y infrared beams and sends this in a form of a touch notification to the VEM main card display coordinator via an RS-422 serial link.

(2) The main cards display coordinator receives the touch notification and identifies it as a frequency button selection. The display coordinator sends an answer image feedback message to the VDM to update the a-g screen. The display coordinator also sends a radio interface (RIF) select command message to the command processor. The RIF select command contains the console number (1-430), frequency selected (1-24), function code = 1 (FCode), and Tx/Rx routing byte (Tx Bit Enable=1) (Rx Bit Enable=1).

(3) The LAN card is requested by the command processor to prepare and transmit the RIP select message via the a-g LAN to the switch bus interface unit (SBIU) of the a-g switch P-node.

b. A-G P-Node Equipment.

(1) The a-g switch bus interface unit (SBIU) receives the message from the a-g LAN and buffers it. It is then available to the bus if software as a receive (RX) and transmit (TX) selection request. The LAN package sends the message to the RIF select handler resident in the high speed central processor unit (HCPU) via the internal C-bus.

(2) The bus if sends a command to the frequency command processing software which connects the RX voice from the a-g fiber optic tie trunk (FOTT) to the controller position through the voice combiner unit (VCU). The VCU combines the received voice signals from the radio/BUEC if cards. The TX voice is connected by the position discrete signal switch circuit card assembly (cca) for the selected frequency. The frequency command processing software will send a confirmation message back to the requested console in a similar fashion.

60. EMERGENCY FREQUENCY SELECTION.

The controller performs emergency frequency selections in the same manner as standard frequencies with the exception of its ptt activation. Emergency frequency ptt is activated by a non-latching icon on the touch screen portion of the VSCS display module (VDM).

61. PTT AND VOICE CONNECTIVITY.

a. Upon controller engagement of push-to-talk (ptt), the VCE sends a ptt signal to the a-g switch, where it is received by the headset/handset (HS) digital line unit (DLU) and forwarded to the position node (P-node) discrete signaling switch (PDSS) cca. The PDSS interrupts the high speed central processor (HCPU), and determines the controllers pulse code modulation (PCM) address of the HS DLU and the virtual radio of the frequency(s) the controller wishes to transmit on. The FOTT formatter unit (FFU) location of the virtual radio, which currently has the PCM address of digital silence (provided by the conference and tone unit), is loaded with the controllers PCM address. Since the radio node (R-node) is configured at reconfiguration, there now exists a voice path from the controllers microphone to the radio interface card. When a controller releases the ptt button, a ptt disconnect request message is sent to the PDSS in the same manner as a ptt. The same pattern of hardware and software execution occurs in a ptt disconnect as a ptt connect, except that the transmit voice path is disabled and the receive voice path is enabled.

b. The controller receives a ptt confirmation by a change in color of the icon on the touch screen display of the VDM.

c. Ptt preemption occurs when a ptt is in progress and a second ptt of higher priority is initiated at another console and gains a-g voice transmission for the frequency. The transmission of the first ptt is interrupted, along with the position receiving a ptt preemption tone followed by the preempting position's transmissions in their HS, regardless of a-g voice routing.

d. Ptt lockout occurs when a ptt is in progress, and a second ptt of equal or lower priority is initiated at another console and is locked out (prohibited from transmitting). The locked out ptt position receives a continuous ptt lockout tone while the ptt is engaged.

62. PAIRED RADIO TRUNK LOCKOUT.
Trunk lockout occurs when two VCE's of the same priority are employing paired radios with the same frequencies (call them A and B) and one VCE has a ptt in progress on a frequency A and the second VCE attempts to ptt on frequency B. The second VCE is stopped from transmitting on frequency B until the controller at the first VCE releases the ptt for frequency A.

63. A-G VOICE CALL RECEPTION.

a. Squelch break is indicated for selected and unselected frequency states, and accompanied by a-g voice in the HS or a-g loudspeaker, depending on the voice routing selection, when the associated frequency is selected and the receiver is enabled.

b. No software processing is required for incoming voice to be routed from the radio interface card to the controller position. Voice reception is disabled during ptt operations. This is accomplished by setting the P-node FOTT frequency display unit (FDU) input source address to the digital silence FOTT slot instead of the usual receive virtual radio FOTT slot.

c. When a squelch break occurs, the radio interface card senses the signal and converts the incoming voice from analog to digital and places it on the R-node PCM bus. The incoming voice from the PCM bus is extracted by the FFU and placed onto the receive virtual radio (VR) FOTT slot.

d. The P-node FDU uses the receive VR FOTT slot as its input source address, thus connecting the incoming voice to the P-node. The P-node FDU routes the incoming voice to the proper voice combiner unit (VCU) slot on the P-node PCM bus. The VCU combines the incoming voices that it receives from the FDU and places this output (combined voice data) into the associated VCE slot on the PCM bus. The VCE is constantly listening to its PCM slot. Consequently, the controller receives the incoming voice at the VCE position.

64. VEARS.
VEARS is activated when a controller inserts a headset into the VEARS module (single, dual or quad). The module removes the control voltage from the primary system (300SS/4-channel or VSCS) and allows access to the remote control equipment (RCE) and the primary radio frequencies. The control transfer of the radio path is accomplished in the RCA/patch rack which closes several relay contacts and opens the path for VEARS operation.

65.-69. RESERVED.

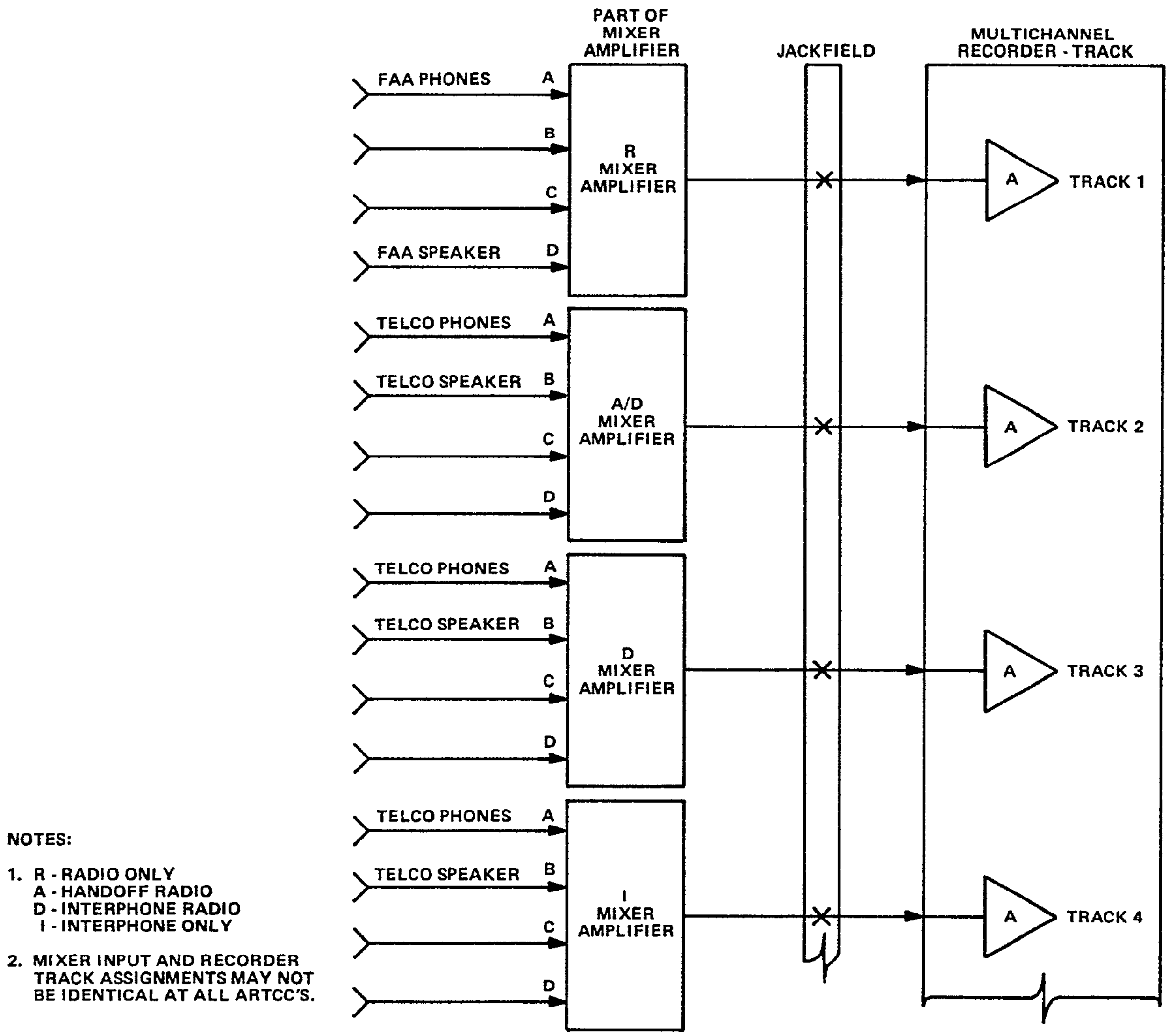

Figure 2-12. Typical Mixer-Recorder Channel Arrangement

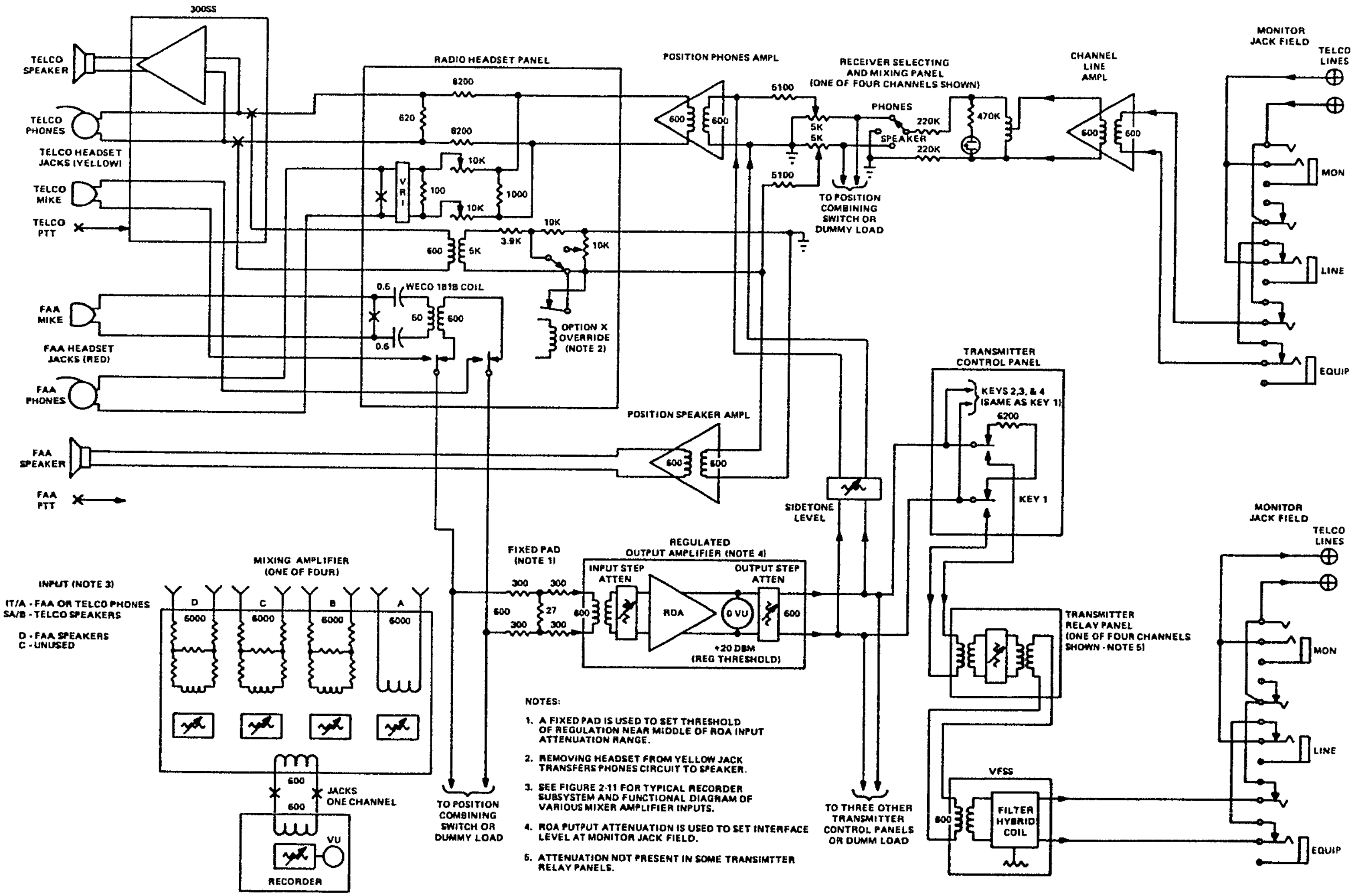

Figure 2-13. ARTCC Speech Circuits, Simplified Schematic Diagram

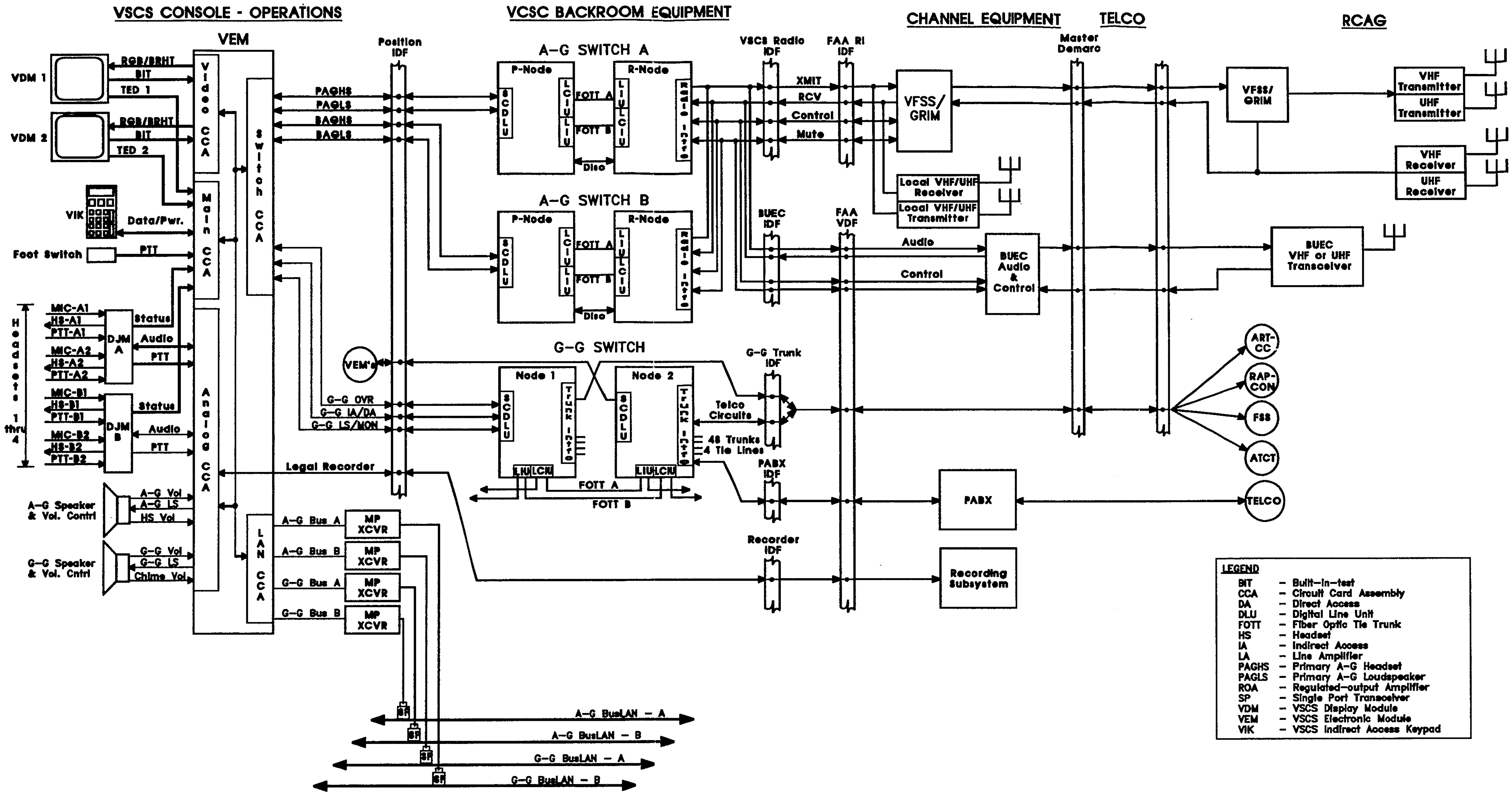

Figure 2-13A. VSCS Simplified Block Diagram

CHAPTER 3. STANDARDS AND TOLERANCES

70. GENERAL.

This chapter prescribes the standards and tolerances for the en route air-to-ground (a-g) communications system, its control subsystem, and the interface audio frequency levels required for proper operation, as defined and described in the latest edition of Order 6000.15B. All key performance parameters and/ or key inspection elements are clearly identified by an arrow placed to the left of the applicable item.

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	*Operating*
71. ARTCC PARAMETERS				
a. Four-Channel Control.				
→ (1) Line Amplifier Output Levels, RCAG or Local Receivers.	103,121a(5)	25V max	+0.-8V,	+0,-8V
→ (2) Regulated Micro-Phone Amplifier (ROA) Input and Output Levels Based on -12dBm 1000Hz Tone at Position Jacks.	120			
(a) Input		-17dBm	±1dB	±2dB
(b) Output		+20dBm	±1dB	±2dB
(3) Regulated Micro-Phone Amplifier (ROA) Tone Regulated.	120	Threshold adjustment +20dBm output on tone	±2dB	Same as initial
(4) Level to Leased Circuit (or Link) at Demarcation Strip (1000Hz tone).[1]	120			
(a) FAA-S-1142a Line		-8dBm	Same as standard	±3dB
(b) Leased Lines		Commissioned value	Same as standard	±3dB
* (c) Zero Loss lines		-8dBm	Same as standard	±3dB *
(5) ARTCC/300SS/1000Hz Interface Levels.	121a			
(a) Telco and FAA Headset Receiving Jack Levels		-15dBm max -27dBm opr -30dBm sidetone	±1dB	±2dB
(b) Speaker Amplifier output Level		+30dBm max	±1dB	±2dB

[1]Operating Power level should not exceed -13dBm maximum averaged over a 3-second interval.

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
(c) FAA Speaker Volume		+30dBm max +10dBm opr +5dBm option "X"	±1dB	±2dB
(d) FAA Phones to 300SS		−15dBm max −27dBm opr	±1dB	±2dB
(e) FAA Option "X" Level from 300SS		−15dBm max −27dBm opr	±1dB	±2dB
(f) 300SS Microphone Level to FAA		−17dBm	±1dB	±2dB
(g) Telco Interphone and Speaker Levels into FAA Mixer Amplifier		−37dBm (interphone) −27dBm (speaker)	±1dB −0, +12dB	±2dB −0, +12dB
(h) FAA Recording Levels into Mixer Amplifier		+10dBm (speaker) −27dBm (phones)	±1dB ±1dB	±2dB ±2dB
(i) Mixer Amplifier Output to Recorder Input		−10dBm (all)	±1dB	±2dB
→ * (6) Local Transmitter Modulation	120 a(7)	90 to 95% max	60 to 95%	Same as initial
→ (7) Local Receiver and Audio Output Level.	121a(14)	0dBm (w/amp) 25V max (w/o)	±1dB +0 to −8V	±2dB +0 to −8V *
(8) 48V DC Power Supply Output Terminals.	106	48V	±4V	±4V
(9) 48V DC Power Supply-Ripple Voltage.	106	Less than 5% of measured dc output	Same as standard	Same as standard
(10) 48V DC Power Supply-Controller's Position.	106	Not less than 40V	Same as standard	Same as standard
(11) 46V AC Power Supply-Output Terminals.	106	46V	±6V	±6V
(12) 46V AC Power Supply-Transmitter Relay Panel.	106	Not less than 38V	Same as standard	Same as standard

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
b. Radio Channel Control.				
(1) Receiving Branch				
(a) Radio receiver, 600-ohm audio output to line or link[1]	121b(5)(e)			
1 FAA line		Commissioned value	Same as standard	±3B
2 Leased line		Commissioned value	Same as standard	±3B
3 Radio link		As required by link system, ≤ −13dBm	As required by link system	As required by link system
* 4 Zero Loss Lines		-8dBm	Same as standard	±3dB *
→ (b) Radio receiver, 600-ohm audio output to selector unit	121b(5)(e)	−15dBm	±4dB	Same as initial
→ (c) Line amplifier, 600-ohm audio output to receiver selector unit	121b(5)(e)	−15dBm	±4dB	Same as initial
(d) Radio receiver interface point; headset volume control maximum cw	121b(5)(k)	−10dBm	±4dB	Same as initial
→ (e) Headset phones jack headset volume control at maximum cw				
1 With telco compression	121b(5)(j)	−18dBm	±4dB	Same as initial
2 Without telco compression	121b(5)(j)	−10dBm	±4dB	Same as initial
3 FAA headset jack	121b(5)(h)	−10dBm	±4dB	Same as initial
(f) Sidetone at telco phones jack, headset volume control set for −20dBm at headset jack	120b(5)(c)3	−32dBm	±4dB	Same as initial
(g) FAA speaker amplifier output, speaker volume control at maximum cw	121b(5)(q)	1.1V ac	±0.5V	Same as initial
→ (h) Telco record drop interface point; volume controls set for −20dBm at headset jack	121b(5)(m)	−30dBm	±4dB	Same as initial

[1]Operating power level should not exceed -13dBm Maximum averaged over a 3-second interval.

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(2) Transmitting Branch				
(a) Telco microphone jack, 1000Hz test tone input	120b(5)	−12dBm	Same as standard	Same as standard
(b) FAA microphone jack, 1000Hz test tone input	Order 6640.2C[2]	Rated output of microphone	Same as standard	Same as standard
→ (c) Radio transmit FAA/telco interface point	120b(5)(c)5	−30dBm	±5dBm	Same as initial
(d) Line or link demarcation strip FAA/telco interface point[1]	120b(5)(c)6			
1 FAA line		Commissioned value	Same as standard	±3dB
2 Leased line		Commissioned value	Same as standard	±3dB
3 Radio link		As required by link system, ≤13dBm	As required by link system	As required by link system
* 4 Zero Loss Lines		-8dBm	Same as standard	±3dB *
→ (e) Level to local transmitter modulator		0 dBm	+0, −12dB	Same as initial
→ (f) Local or remote transmitter modulation on 1000Hz test tone	120b(5)(c)10 Order 6480.6B[3] chapter 7	90 to 95 percent	60 to 95 percent	Same as initial
→ (g) Transmitter voice modulation	120b(5)(c)12 Order 6480.6B[3] chapter 7	90 to 95 percent	60 to 95 percent	Same as initial
(3) Recording Branch.				
→ (a) FAA mixer amplifier output (recorder amplifier input); all recorders	121b(5)(n)	−10dBm	±4dB	Same as initial
→ (b) Recorder transport input level	121b(5)(o)	0 vu	±4 vu	Same as initial

[1] Operating power level should not exceed -13dBm maximum averaged over a 3-second interval.
[2] Order 6640.2C, Maintenance of Audio and Speech Equipment.
[3] 6480.6B, Maintenance of Terminal Air-to-Ground (A-G) Communication Facilities.

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
c. VSCS	Order 6690.3[1]			
* d. VEARS.				
→ (1) Transmit output to radio control equipment (–9 dBm jackbox input level).				
(a) Transmit level	110d(1)(c)	Commissioned Value	±4 dBm	±6 dBm
(b) Sidetone level	110d(1)(f)	–30 dBm	±4 dBm	±6 dBm
(2) Receive input at position (–17 dBm input level to RCA card).	110d(2)(c)			
→ (a) Maximum headset level		–15 dBm	±2 dBm	±4 dBm
→ (b) Minimum headset level		–47 dBm	±2 dBm	±4 dBm
→ (3) Record input: receive, transmit	110d(3)(d) 110d(3)(f)	–10 dBm	±2 dBm	±4 dBm
(4) Power Supply Voltage		+12 V dc	+3, –0 V	Same as initial *
72. RCAG PARAMETERS.				
→ a. **Transmitter Modulation, Based on Nominal 1000 Hz Tone at Input to RCAG from Telco.**	122	90 to 95 percent max	60 to 95 percent	Same as initial
→ b. **Receiver Audio Output Level at FAA/Telco Demarcation Strip (1000 Hz tone).**[2]	122f			
(1) FAA-S-1142a		–8 dBm (bridging)	Same as standard	±3 dB
(2) Leased lines		Commissioned value	Same as standard	±3 dB
(3) Zero loss lines		–8 dBm	Same as standard	±3 dB
c. **48 V DC Power Supply Output Terminals.**	106	48 V	±4 V	±4 V
d. **48 V DC Power Supply Ripple Voltage.**	106	Less than 5 percent of dc	Same as standard	Same as standard
NOTE: Standards and tolerances for associated equipment such as BUEC, receivers, transmitters, VFSS, etc., are contained in the specific equipment handbook.				
73.-79. **RESERVED.**				

[1] Order 6690.3, Maintenance of Voice Switching and Control System (VSCS).

[2] Operating power level should exceed –13 dBm maximum averaged over a 3-second interval.

SO SUPPLEMENTAL PAGE

*81d-SO1. QUARTERLY. A check of the emergency telephone patch system (Hi-Jack phone patch system) shall be made with the Regional Operations Center on the second Wednesday of January, April, July and October, at any time between 8:30 a.m. and 5:00 p.m. Refer to AFP 6500.1, Chapter 229, Change 164. *

* *

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CHAPTER 4. PERIODIC MAINTENANCE

* **80. GENERAL.** All periodic maintenance tasks in this chapter have been removed from this Order. The maintenance tasks are either duplicated in other maintenance handbooks, or refer to obsolete equipment. Refer to the latest edition of Order 6000.15 for additional general guidance. *

PERFORMANCE CHECKS

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
*		
81. Withdrawn by CHG 12		
82. Withdrawn by CHG 12		
83.-99. RESERVED.		

*

CHAPTER 5. MAINTENANCE PROCEDURES

100. GENERAL.

This chapter establishes the procedures for accomplishing the various essential maintenance activities that are required for the en route air-to-ground (a-g) communication system on either a periodic or incidental basis. The chapter is divided into sections. The first section describes or references the procedures to be used in making the performance checks listed in chapter 4. The second section describes the other maintenance tasks procedures. The third section contains special maintenance * procedures that are not scheduled. When operating in the VSCS mode, refer to Order 6690.3 for maintenance procedures. Refer to Order 6000.15B for additional general guidance. For a list of test equipment, see table 5-1, below.

Table 5-1. TEST EQUIPMENT LISTING

Generic Name	*Preferred Item*	*Substitute Item*
Audio oscillator, 20 to 20,000Hz, manual adjustment of sinusoidal output	Fluke digital function generator	Hewlett Packard HP-200
Counter, electronic frequency	Systron-Donner Model 6152a or equal	None
Noise test set, weighted C-message, with dBrnc scale, including 3kHz flat noise scale	Wavetek Model 425 Transmission Level Test Receiver	Northeast Electronics Model TTS-37B Noise Measuring Set
Same as above	Northeast Electronics Model TTS-44 Transmission Test Set	Same as above
Same as above	Wavetek Model 430 Digital Transmission Multimeter	Same as above
Rf signal generator	Communication Service Monitor, CSM-1, or equal	Hewlett Packard Model 608D, E
Transmission test set with dB, dBm, VU, and rms voltage scales	Wavetek Model 430 Digital Transmission Multimeter	Alectra Model 11B dBm/dBa meter
Transmission test set sender-receiver companion units for frequency attenuation, impedance, and noise analysis of a channel	Wavetek Model 424 Sweep Transmitter. Wavetek Model 425 Transmission Level Test Receiver	None
Vacuum-tube voltmeter (vtvm)	Triplett Model 801	Ballantine Model 400D
Oscilloscope	Tektronix Model 465	Tektronix Model 545
Volt-ohm-milliameter (vom) 20,000 to 200,000 ohm impedance	Wavetek Model 430 Digital Transmission Multimeter	Triplett VOM Model 630NA or Simpson VOM Model 260

Section 1. PERFORMANCE CHECK PROCEDURES

101. FAA FORM ENTRIES.

Order 6000.15A contains policy, guidance, and detailed instructions for field use of FAA Form 6600-6, Technical Performance Record (formerly FAA Form 6530-1, as applicable to the En Route Air-to-Ground Communication Facilities). Entries shall be made in accordance with the instructions published in Order 6000.15A. Figure 5-1 is a sample FAA Form 6600-6 that shows typical entries for normal and unsatisfactory conditions that may be encountered.

102. AURAL QUALITY MONITORING.

Aural monitoring of the quality of speech transmission on an a-g channel provides a means to determine the usability of the channel. Off-the-air monitoring using a vhf or uhf receiver can provide, from a remote point, an indication of the quality of the entire a-g channel from microphone to transmitter. The preferred method for aural monitoring at the ARTCC, the RCAG, or other remote facilities is to monitor the controller's transmission by bridging an amplifier with a headset receiver. It is important that only high impedance bridging connections be made; under no circumstances, on an operational channel, should the amplifier be patched into line or equipment jacks that will open the channel. All voice channels shall be aurally monitored in accordance with the periodic performance check in chapter 4.

103. AUDIO LEVEL CHECKS.

Periodically, perform audio level checks at designated FAA/telco/300SS interface points. (These points are shown in figures 5-4 through 5-6, section 2.) The standard audio test signal is a 1000Hz test tone. The standard rf test signal, applied at the antenna input of a receiver, is a 50μV signal that has been modulated 30 percent with a 1000Hz tone. Insert the standard audio test tone into the position microphone jack(s) via the audio test fixture (test box). (The audio test fixture schematic diagram is shown in figure 5-3, section 1.) Make a high-impedance bridging measurement with a power level meter at equipment inputs and outputs and also at the designated interface points. When making such checks, it is important to ensure that tones or clicks are not introduced into operational circuits and that circuit interruptions are not caused by inadvertently lifting lines or equipment when inserting jacks. If available, use monitor jacks that are already bridged on the channels for these checks. Use the receiving and transmitting end-to-end lineup adjustments of paragraph 120, 121, and 122 of this chapter to establish the system levels within the initial tolerances of chapter 3. These lineup adjustments are considered periodic maintenance tasks; they should be performed at * least annually and performed at the same time the * associated telco circuit receives its net loss and frequency attenuation check. At any other time, adjustments to channel attenuators, amplifier gains, and amplifier regulations shall be made ONLY when conditions warrant, and only under controlled conditions.

104. AUDIO LEVEL CHARTS.

Using the lineup procedures in paragraphs 120 through 122 prepare local audio level charts for each channel when levels are initially established. Enter the values at the "standard" test points as shown in figure 5-2. The level diagram then serves as a reference for quickly determining that attenuator settings for such units as regulated output amplifiers, line amplifiers, and mixing amplifiers remain at their optimum positions. Any disturbance can be immediately corrected. For example, once regulation is obtained at the proper threshold of the microphone amplifier, the input attenuator rests at a stable setting. If the setting must be changed, it indicates a fault somewhere in the channel that must be corrected. After troubleshooting is completed, return the attenuator to its former position for normal operation. The setting of the regulated output amplifier (ROA) output attenuator is important in obtaining the proper FAA/telco interface demarcation strip level. Refer to such entries on the charts when accomplishing the monthly audio level performance checks of chapter 4.

105. ALARMS.

a. Object. The object is to check the aural and visual alarm signals during a simulated failure condition.

b. Discussion. The failure-sensing circuits of the recorders, the 48V dc and 46V ac fuses, and the 48V dc and 46V ac power supplies are subject to failure; therefore, their operation should be checked at regular intervals. The aural/visual alarm indicators are located in either the equipment room or the operating quarters.

(1) Recorder failure alarms are initiated when tape motion or tape breakage sensors operate and when the power supply/bias oscillator fails.

(2) Fuse failure alarms for 48V dc and 46V ac

SO SUPPLEMENTAL PAGE

105-S01. Alarms. The procedure for checking the fuse alarm will cause a momentary interruption of air/ground communications service when performed on Type HKA fuseholders. Therefore, the checks should be performed during a period of low air traffic activity. The momentary interruption shall be coordinated with the Air Traffic watch supervisor. Check the alarm/failure indication function of each Type HKA fuseholder in the system.

TECHNICAL PERFORMANCE RECORD — **VHF/UHF AIR/GROUND RECEIVERS/TRANSMITTERS**

FACILITY	LOCATION (City, State, airport, other)	DATE (From—to)
RCAG	ATLANTA, GEORGIA	

TYPE RECEIVER	SERIAL NO.	FREQUENCY	TYPE TRANSMITTER	SERIAL NO.	FREQUENCY	SUPERVISOR (Signature)
AN/GRR-23	—	300 MHz	AN/GRT-21	—	300 MHz	

DATE	TIME (GMT)	RECEIVER SENSITIVITY µV	RECEIVER SQUELCH THRESHOLD µV	RECEIVER AVC LEVEL CONTROL dB	RECEIVER FREQUENCY MHz	RECEIVER SELECTIVITY 6dB BANDWIDTH KHz	RECEIVER SELECTIVITY 60dB BANDWIDTH KHz	RECEIVER NON-SYMMETRY (%)			TRANSMITTER POWER OUTPUT WATTS*	TRANSMITTER VSWR*	TRANSMITTER FREQUENCY MHz	TRANSMITTER % MODULATION VOICE	REMARKS	INITIALS
NOMINAL		3-5	1.5-5	3-4	299.985 300.015	30-31 MIN	80 MAX	15-20			8-12	1.8-2.8/1	299.985 300.015	60-95		
5/4	08:00	4	3	3.5	300	31	70	17			10	1.8/1	300	80	CHECKED OK	BT
8/2	14:00	4.5	2	4	300	32	75	16			6	1.8/1	300	70	REPLACED WEAK FINAL	BT
8/2	16:00										10				CHECKED OK	BT
11/3	20:00	4.5	2	3	300	31	70	18			10	3/1	300	85	REPLACED BENT ANT. CABLE	BT
11/3	22:00											2/1			CHECKED OK	BT

SAMPLE

*Measure at transmitter.

FAA Form 6600-6 (3-79) Formerly FAA Form 6530-1 (3-76) which will be used

☆ U.S.G.P.O.:1982-570-486/226

Figure 5-1. Sample FAA Form 6600-6

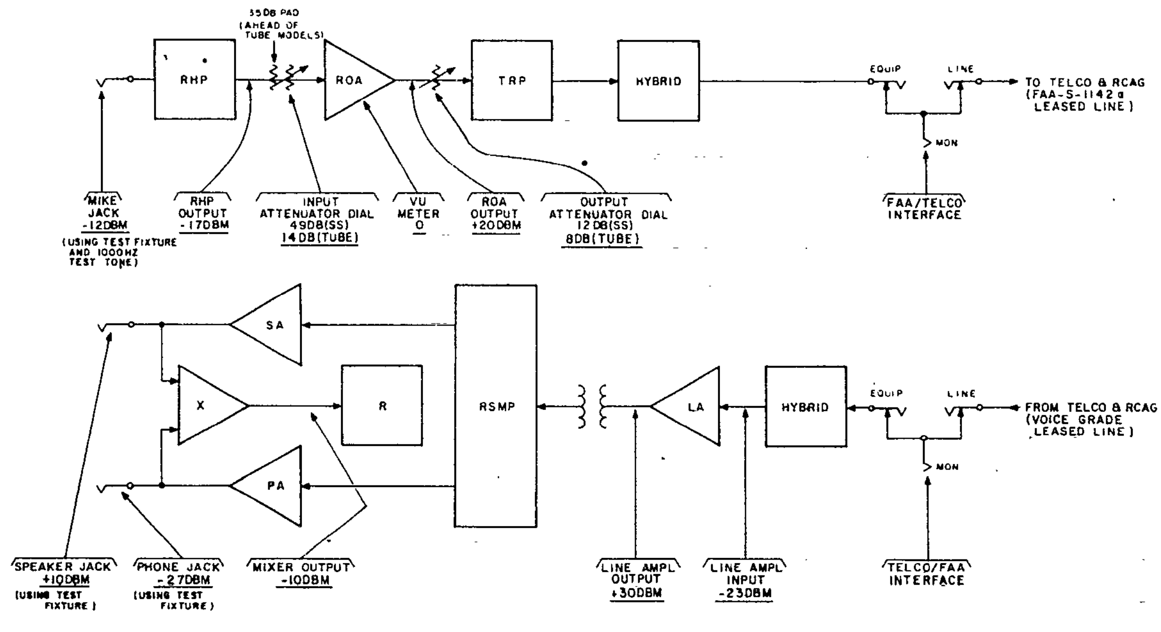


Figure 5-2. Typical Audio Level Performance Check Chart

circuits are initiated when a monitored fuse fails, causing operation of the failure sensing device.

(3) Power-supply failure alarms for the 48V dc and 46V ac circuits are initiated when a monitored power supply fails and actuates the sensing relays. This alarm feature is not provided in some facilities; therefore, no alarm checks are required at these facilities.

c. Test Equipment Required. No test equipment is needed for the recorder and power supply failure alarms. When a type 35 fuse is used, a 100-ohm 5W resistor is necessary. When signal-indicating fuses are installed, a burned-out fuse is necessary to test actuation of the alarm.

d. Conditions.

(1) Check recorder alarms when transport changeover is imminent.

(2) Perform power supply and fuse alarm tests during hours of minimum traffic.

NOTE: The procedure for checking the fuse alarm will cause a momentary interruption of air/ground communications service when performed on the pin-actuated type fuses. The momentary interruption shall be coordinated with Air Traffic.

e. Detailed Procedures. For 152-channel recording equipment checks, refer to the Mincom Division-3M, High Capacity Audio Recording and Reproducing System instruction book.

(1) Recorder Alarms. Determine that an alarm indication occurs (and that normal indication is restored after tests) when the following monitored conditions are checked for each recorder.

(a) Operate the tape motion sensor for an alarm condition.

(b) Operate the tape break sensor for an alarm condition.

(c) Turn off the ac power switch of the operating power supply/bias oscillator.

(2) Fuse Alarm, 48V dc and 46V ac Grasshopper Type.

(a) Simulate a fuse failure by momentarily bridging a 100-ohm, 5W resistor across the power supply bus and the alarm bus.

(b) Determine that the alarm indicator(s) is energized. If not, take corrective action.

(c) Remove the shorting resistor.

(d) Determine that the alarm indicator(s) is de-energized. If not, take corrective action.

(3) Fuse Alarm, 48V dc and 46V ac Pin-Actuated Type.

(a) Simulate a fuse failure by inserting a defective fuse into a spare fuseholder.

(b) Determine that the alarm indicator(s) is energized. If not, take corrective action.

(c) Remove the defective fuse.

(d) Determine that the alarm indicator(s) is deenergized. If not, take corrective action.

(e) Repeat the procedure for each separate fuse panel.

(f) Leave the buzzer switch in the activated position.

106. POWER SUPPLY VOLTAGES.

The power supplies in each a-g communication facility are a critical component of the transmitting and receiving control system. A power-supply failure will cause loss of control of all radio channels associated with it. Measure the output voltage, the ripple voltage of the dc supplies, and the voltage at each controller's position for complete control system evaluation. If voltage levels are not within the tolerances specified in chapter 3, take corrective action. The following items should be considered. (a) Performance checks are most meaningful when tests are made under maximum load conditions, (b) the dc voltage at a controller's position may drop below the critical level if maximum load conditions for a given installation are exceeded, and (c) the test should be performed during hours of minimum traffic for the least disturbance or interruption to normal system operation.

107. OPERATING CONSOLE VFSS FUNCTION CHECK.

To perform a VFSS function check from the controller's position, actuate the transmitter channel selector switch and the receiver selector and mixing panel (RSMP) selector switch, then press the ptt switch on headset or microphone. Check main/standby transmitter and receiver functions from this position and, when performing these checks, observe that the associated indicator lamps are properly lit. Check the buzzer alarm that is actuated by the transmitter selector interlock circuits by selecting and keying a channel of this position when the channel is in use at another position. Observe that the neon indicators on the RSMP are properly flickering when speech is being received on any receiver channel whether selected or not.

108. TELCO LOOPBACK AND LINE-SWITCHING EQUIPMENT.

a. Loopback equipment, where provided, is maintained by telco. Two types of loopback equipment may be encountered, depending on the facility. One type is for remote testing of a line from the ARTCC and uses a 2400Hz telco tone to actuate the loopback feature at the RCAG. To do this, the ARTCC technician inserts a 1000Hz test tone on the ARTCC jackfield transmit circuit (into the telco line) and notes whether it is returned on the receive path. The SS-1 is a second type and is for operational switching of a spare line upon failure of the primary line. In the SS-1, the spare line is obtained manually by dialing.

b. To check the manually switched SS-1, switch the spare line and test it by keying the transmitter on the channel. Listen for a "kick-back" sound in the receive line to ascertain that the transmitter is keyed.

109. RCC PERFORMANCE CHECKS.

a. **Object.** The purpose of this test is to verify that the proper audio amplification and signal levels are provided by the radio channel control equipment to the controller, recorder, and telco interfaces.

b. **Test Equipment Required.**

(1) Transmission test set.

(2) Audio test set (FA-9491 or equivalent).

c. **Conditions.**

(1) Initially, all modules of the solid-state radio channel equipment shall be tested and preliminary adjustments performed, using the test set type FA-8165/4. During these preliminary tests, obtain regulation of the microphone input level between −55dBm and −35dBm to a maximum transmit channel audio output of 0 dBm (+0, −5dB). In addition, the mixer amplifier output from the recorder-monitor module shall be adjusted for −10dBm with a −30dBm level to the telco 1 input. This adjustment is made with the potentiometer, R17, on the recorder-monitor module.

(2) The values of resistors R18 and R20 in the JU-612 telco high-level input shall be selected based on the FAA telco interface send level from the telco switching system. Refer to the JU-612 instruction booklet for the resistor values versus input level.

d. **Detailed Procedure.**

(1) Set up the test equipment as shown in figure 5-2A. If signal inputs are made with a 600-ohm termination, refer to figure 5-2B for the meter correction factor for the 1800-ohm single-channel input impedance at the selector unit. The impedance is based on the number of combined frequencies or positions.

(2) Apply a receive audio level of −15dBm, 1000Hz to the channel being tested. Measure the level with a high impedance meter bridged across the selector unit input/frequency patch field.

(3) Select headset and set the headset volume control to maximum cw. The level at the FAA headset jack shall meet the tolerance prescribed in chapter 3.

(4) Unplug the test set from the FAA headset jack. Plug the test set into the telco jack and select telco radio position. The receive audio to telco and the level at the telco jack shall meet the tolerances in chapter 3.

(5) Unplug the test set from the telco jack. Plug the test set into the FAA headset jack and deselect telco radio position. Reduce headset volume control (R1110) to obtain a −20 dBm at the FAA headset jack. The recorder-monitor module output level and the record level on the recorder shall meet the tolerances prescribed in chapter 3.

(6) Unplug the test set from the FAA headset jack. Plug the test set into the telco jack and select telco radio position. Adjust the headset volume control for −20dBm at the telco jack. The receive audio to telco, the recorder-monitor module output and the telco record drop shall meet the tolerances prescribed in chapter 3. Verify that the telco record drop is of the proper phase by flipping the record pair of wires. It is phased correctly when the level at the recorder is at maximum.

(7) Plug the test set into the FAA jack and deselect the receive audio. Do not change the headset volume control setting. Terminate the test-channel transmit audio output in a 600-ohm meter.

(8) Apply a −12dBm, 1000Hz transmit tone to the audio test fixture, and select and key the test channel. Adjust the TRANSMIT LEVEL ADJ potentiometer (R1209) of the lamp brightener for exactly 0 dBm output (reference paragraph 109).

(9) Read the transmit sidetone at the audio test fixture. The transmit sidetone and the recorder-monitor module output shall meet the tolerance prescribed in chapter 3.

(10) Unplug the test set from the FAA headset jack. Plug the test set into the telco jack and select telco radio position. The transmit level from telco and the recorder-monitor module output level shall meet the tolerances in chapter 3.

CAUTION: The following settings (steps (11) and (12)) will produce a 1000Hz tone in the control room. Obtain concurrence from the air traffic (AT) watch supervisor before proceeding.

(11) Unplug the test set from the telco jack. Select the FAA speaker and verify that a satisfactory recording can be obtained.

(12) Deselect the FAA speaker and activate the telco speaker. The recorder-monitor module output level should vary linearly with the telco speaker volume control setting. Verify that a satisfactory recording can be obtained.

* 110. VEARS PERFORMANCE CHECKS.

a. **Objective.** The purpose of this check is to verify that the proper audio levels are provided by the VEARS to the air traffic controller, radio interface, and recorder.

b. **Test Equipment Required.**

(1) Transmission Test Set, TTS-44, or equivalent.

(2) Audio Test Set, FA-9491, or equivalent.

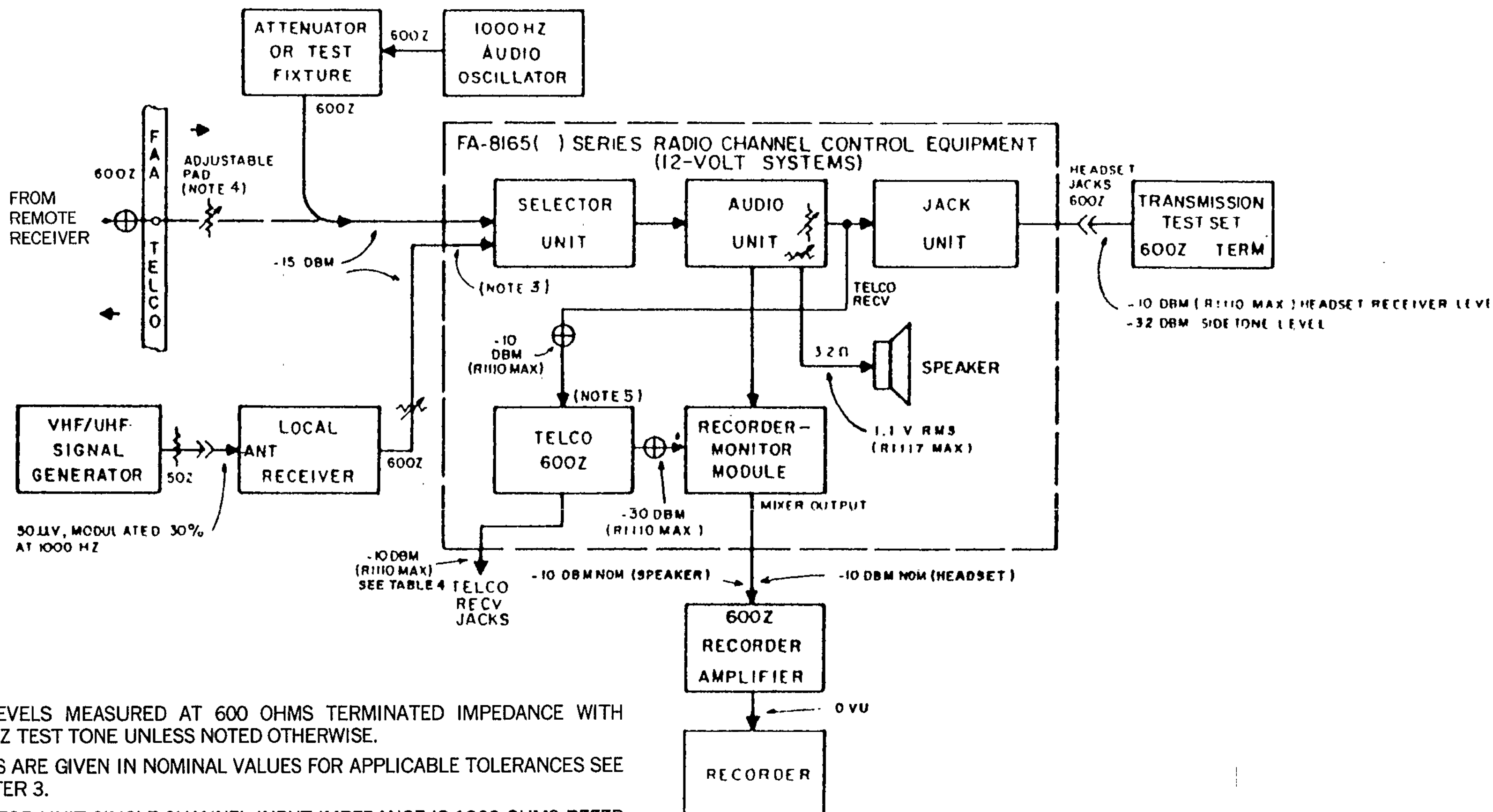
c. **Conditions.** VEARS must be activated by inserting a headset or FA-9491 into the VEARS module at the position under test. The transmit path must be disconnected from the radio control equipment to ensure that no audio tones are transmitted over the radio channel.

NOTE: The FA-9491 is internally terminated in 600 ohms. The TTS-44 receive side must be set to BRIDGE.

NOTE: All tests must be performed with the input and output circuit disconnected from any active radio channel. Remove the demarcation clips, if necessary.

d. **Detailed Procedure.**

(1) Transmit. *



NOTES:

1. ALL LEVELS MEASURED AT 600 OHMS TERMINATED IMPEDANCE WITH 1000HZ TEST TONE UNLESS NOTED OTHERWISE.
2. LEVELS ARE GIVEN IN NOMINAL VALUES FOR APPLICABLE TOLERANCES SEE CHAPTER 3.
3. SELECTOR UNIT SINGLE-CHANNEL INPUT IMPEDANCE IS 1800 OHMS REFER TO FIGURE 5-2B FOR 600-OHM METER CORRECTION FACTOR.
4. STRAPPABLE (OR ADJUSTABLE) PAD DROPS 1000HZ INCOMING LEVEL TO REQUIRED NOMINAL SELECTOR INPUT LEVEL.
5. TELCO CIRCUITS MAY CONSIST OF LEASED SWITCHING SYSTEMS AND LANDLINES. FAA/TELCO INTERFACE POINTS SHOWN AS ⊕

Figure 5-2A. Radio Channel Control (RCC) Receiving Channel Level Checks

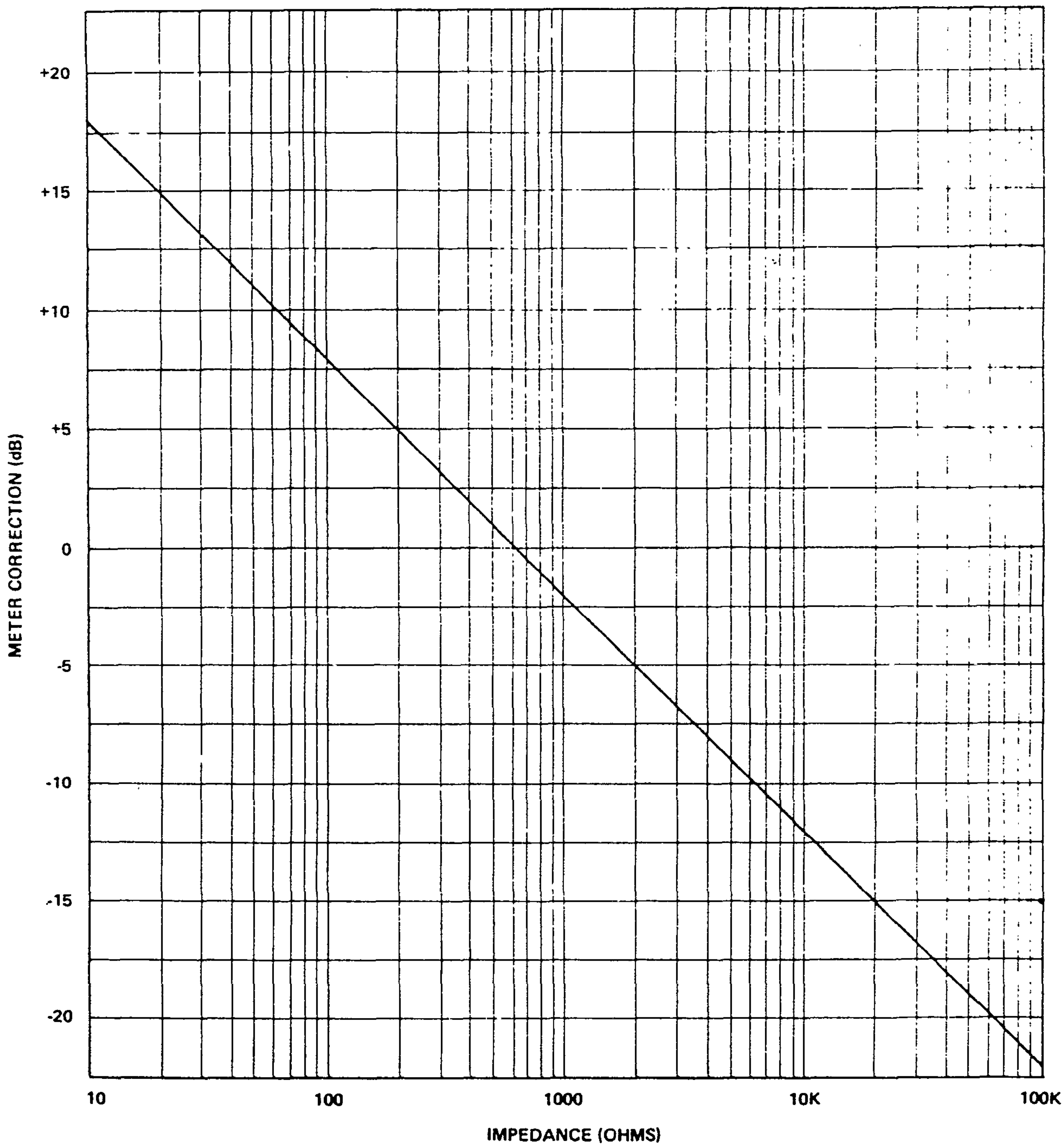


Figure 5-2B. Meter Correction Graph

* NOTE: Set the headset (HDST) volume control to maximum and the loudspeaker (LS) volume control to minimum when performing these procedures.

(a) At the position under test, insert the FA-9491 into the VEARS module. Connect the TTS-44 send, -9 dBm, 1004 Hz, into the FA-9491. Select push to talk (ptt) to ON.

(b) At the RCA/patch rack, connect the second TTS-44 receive, 600-ohm TERM, across the transmit pair on the demarcation block for the frequency under test.

(c) Adjust the XMT AUDIO potentiometer on the front panel of the RCA card for the level specified in paragraph 71d(1)(a) on the TTS-44.

(d) Insert a second patch cord from the receive side of the FA-9491 to the TTS-44 receive side. Ensure that the TTS-44 is in BRDG mode.

(e) At the RCA rack, place the RCA card associated with the frequency under test on an extender card and reinsert into the cardcage.

(f) Adjust the SIDETONE potentiometer, R23 for the level specified in paragraph 71d(1)(b) on the TTS-44 at the position.

(2) Receive.

(a) At the position, switch the TTS-44 send to receive, 600-ohm TERM.

(b) At the RCA/patch rack, disconnect the TTS-44 from the transmit pair to the receive pair at the demarcation block. Switch the TTS-44 to send. Inject a send signal of -17 dBm, 1004 Hz, 600-ohm BRDG, onto the receive pair. Turn the volume control at the position to maximum (clockwise). Switch the TTS-44 at the position to receive, 600-ohm BRDG.

(c) Adjust the RCV AUDIO potentiometer on the front panel of the RCA card for the level specified in paragraph 71d(2) on the TTS-44 at the position.

(3) Record.

* (a) At the position under test, switch the TTS-44 to send, -9 dBm, 1004 Hz. Select push to talk (ptt) to ON.

(b) At the RCA rack, place the RCA card associated with the frequency under test on an extender card and reinsert into the cardcage.

(c) At the RCA/patch rack, disconnect the TTS-44 from the receive pair and connect it to the record level test points TP4A, and TP4B. Switch the TTS-44 from send to receive, 600-ohm, 1004 Hz, TERM.

(d) Adjust the REC LEVEL potentiometer, R29, on the RCA card for the level specified in paragraph 71d(3) on the TTS-44.

(e) Disconnect the TTS-44 at the position. Insert a second patch cord into the TTS-44 at the RCA/patch rack and connect to the receive pair on the demarcation block. Send a -17 dBm, 600-ohm, 1004-Hz signal.

(f) Connect the receive side of the TTS-44 to the record level test points TP4A and TP4B. Adjust the RCV TO REC COMBO potentiometer, R53, for the level specified in paragraph 71d(3) on the TTS-44.

(4) Remove extender cards and disconnect all test equipment. Reconnect the demarcation clips, if necessary, to restore the circuits. Verify that the position is back in service with VSCS.

111. VEARS OPERATIONAL CHECKS.

a. Objective. This procedure provides a method to ensure that VEARS used by air traffic personnel for control purposes is suitable for operation.

b. Discussion. VEARS used in the enroute environment requires a periodic check by air traffic to verify its availability and usability.

c. Test Equipment Required. None.

d. Procedure. Request that air traffic personnel activate VEARS under test on an operational channel to ensure proper functioning.

112.-119. RESERVED. *

Section 2. OTHER MAINTENANCE TASK PROCEDURES

120. ARTCC TRANSMITTING LINEUP.

a. Four-Channel Control.

(1) Object. The object is to establish and maintain the maximum FAA/telco interface level specified in paragraph 71a(4) at the ARTCC demarcation strip on tone (1000 Hz), and to reduce the amount of regulation on speech in the transmitting channel so as to reduce noise pumping, background noise, and distortion.

(2) Discussion. The lineup procedure uses an audio test fixture (figure 5-3) to inject a –12 dBm 1000 Hz test tone into the microphone jack at the radio position in the ARTCC. The input level of the injected signal is controlled by adjusting the output of the audio oscillator, which is usually set at –12 dBm. This procedure allows for setting the initial threshold regulating point in the regulated output amplifier (ROA) at +20 dBm. After the tone regulation threshold is set, reduce the tone level by means of the ROA output attenuator for a maximum level as specified in paragraph 71a(4) at the FAA/telco demarcation strip interface. With this setting completed, the ROA will provide sufficient gain to modulate the transmitter for different voice levels. The level appearing at the ARTCC demarcation strip is dropped by the nominal telco circuit loss before it appears at the input of the transmitter at the RCAG. Initially, with the test tone at the nominal input to the RCAG, the transmitter is adjusted for 95-percent maximum modulation. (Refer to figure 5-4 for the end-to-end transmitting level diagram.)

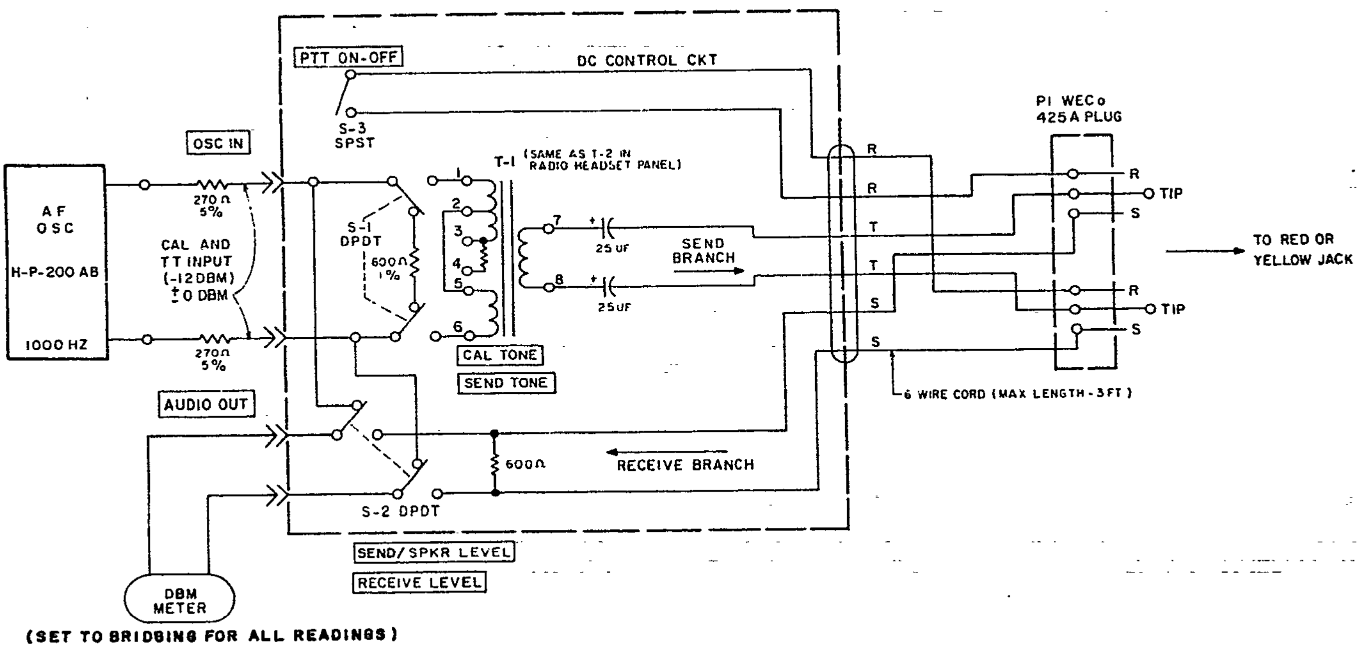


Figure 5-3. Audio Test Fixture, Schematic Diagram

(3) Test Equipment Required.

(a) Audio oscillator or audio function generator, 600-ohm output.

(b) Transmission test set.

(c) Audio test fixture (referred to as "test box"). (See figure 5-3.)

(4) Conditions.

(a) Coordinate release of radar control position with releases of associated controller position and at least one communications channel normally used by the sector radar controller.

(b) Remove associated fs sender(s).

(c) Place position combining switch in OFF, if the control sector is so equipped.

(d) Ensure that vf hybrid units are balanced.

(5) ROA Adjustment, Tube Type.

(a) Remove fs sender.

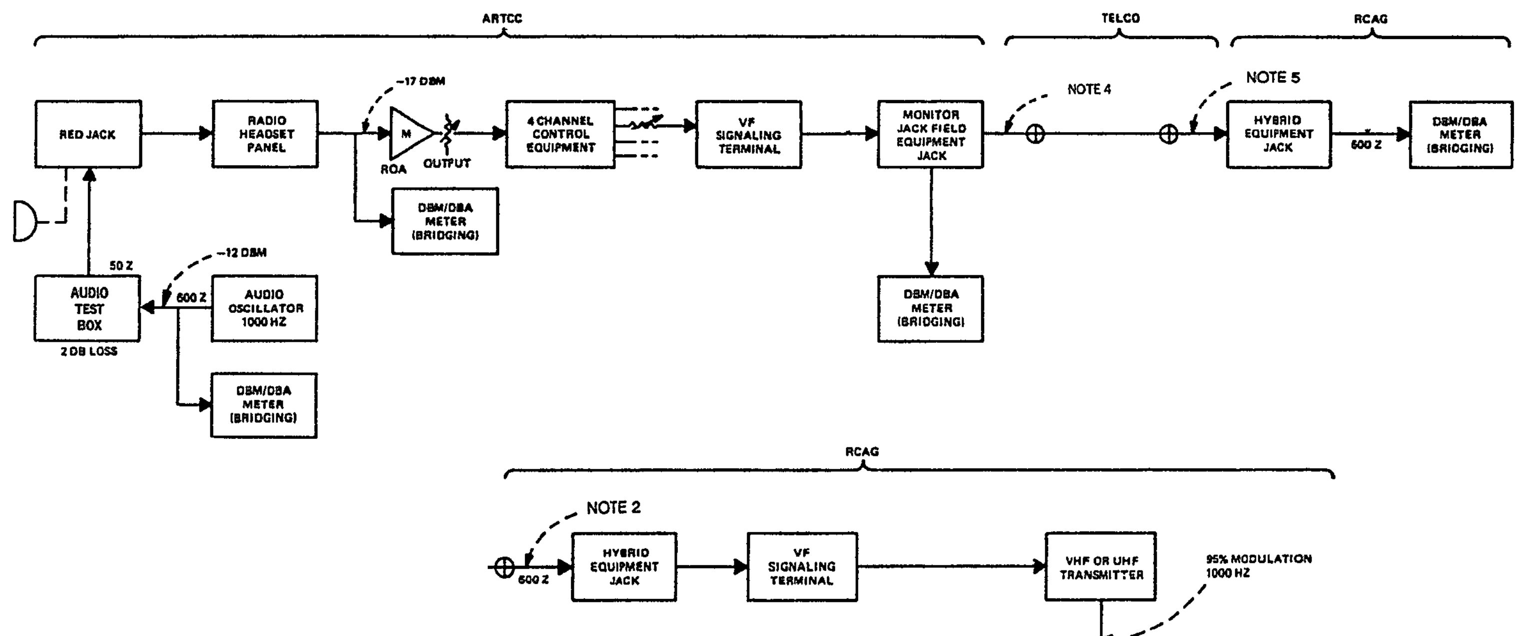
(b) Set the input attenuator to maximum (full counterclockwise (ccw) position). Set the output attenuator to +20 dBm. Set the regulation control to minimum (full ccw position).

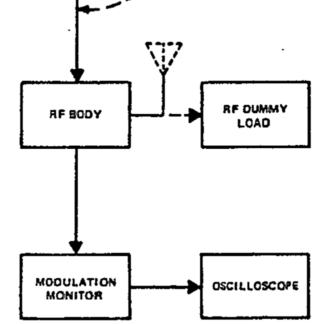
(c) Connect a power level meter to the AUDIO OUT jack on the test box and a 1000-Hz oscillator to the OSC IN jack.

(d) Plug the test box into the red jack. Adjust the 1000-Hz oscillator to –12 dBm with S-1 set to CAL TONE position and S-2 set to SEND/SPKR LEVEL position on the test box.

(e) Set S-1 to SEND TONE and S-3 to PTT ON. Check the input of the associated ROA for approximately –17 dBm. Check the output for something greater than +20 dBm.

(f) Record ROA input of all position jacks by moving the test signal from jack to jack. Operate telco turnkey switch to radio as needed.





NOTES:

1. NOMINAL LEVELS ARE SHOWN IN THE DIAGRAM. REFER TO THE CHAPTER 3 STANDARDS AND TOLERANCES FOR INITIAL AND OPERATING TOLERANCES OR LIMITS.

2. A SIMULATED ARTCC SEND LEVEL MAY BE INJECTED IN THE HYBRID EQUIPMENT JACK AT THE RCAG.

3. ⊕ IS A TELCO/FAA INTERFACE POINT.

* 4. -8dBm FOR FAA-S-1142a LINES.
COMMISSIONED VALUE FOR LEASED LINES.
-8dBm FOR ZERO LOSS LINES. *

5. LEVEL DEPENDENT ON COMMISSIONED VALUE AND LINE LOSS.

Figure 5-4. Transmitting Audio Level Lineup Diagram

(g) Compare ROA input levels as recorded for all position jacks. If levels differ more than ±2dB, begin troubleshooting to clear the fault.

(h) Adjust the input attenuator for +20dBm output. The internal volume unit (vu) meter should read approximately zero.

(i) Adjust regulation control until the +20dBm output just starts to drop. This sets the regulating point at +20dBm output for −12dBm input to the test box.

(j) Adjust the output attenuator on the ROA to obtain the level as specified in paragraph 71a(4), bridged at the FAA demarcation jack.

(k) Set S-3 to OFF.

(6) ROA Adjustment, Solid-State Type.

(a) Remove fs sender.

(b) Bridge a power level meter to the test box AUDIO OUT jack., Connect oscillator to the OSC IN jack.

(c) Plug the test box into the red jack. Adjust the 1000Hz oscillator to −12dBm with S-1 set to CAL TONE position and S-2 set to SEND/SPKR LEVEL position on the test box.

(d) Plug the ROA into an extender board for ease of adjusting the output level control.

(e) Set the input attenuator to 57dB, and with regulator switch ON set the output attenuator on rear panel to zero. Set the screwdriver output level control to maximum clockwise (cw).

* (f) Set the transmitter control panel (TCP) selector to frequency desired. (If paired frequency, select both VHF and UHF frequencies.) *

(g) Set test box S-1 to **SEND TONE** and S-3 to **PTT ON.** Check the input of the ROA for approximately -17dBm with meter bridged.

(h) Record ROA input of all position jacks by moving the test signal from jack to jack. Operate telco turnkey switch to radio as needed.

(i) Compare ROA input levels as recorded for all position jacks. If levels differ more than ±2dB, begin troubleshooting procedures to clear the fault.

(j) Adjust the input attenuator until the output just exceeds +20dB. Adjust the output level control to reduce level exactly to +20dB, output with −12dBm input to the test box. DO NOT READJUST OUTPUT LEVEL CONTROL OR INPUT ATTENUATOR FROM THIS STEP ONWARD.

(k) Adjust the output attenuator on the ROA or the attenuator on the associated transmitter interlock unit to obtain the level specified in paragraph 71a(4), bridged at the FAA demarcation jack.

(l) Set test box S-3 to PTT OFF.

(7) Local Transmitter Adjustment.

(a) With the input to test box adjusted to −12dBm, apply the output of the test box into the red jack.

(b) Set the local transmitter audio attenuator control for 95-percent modulation on the 1000Hz test tone.

b. Radio Channel Control.

(1) Object. This procedure provides adjustment, on a 1000Hz sine-wave test tone and standard voice test count, of the transmitting branch elements of the system.

(2) Discussion. A standard 1000Hz sine-wave test tone, approximately equivalent to the microphone level, is injected into the microphone jacks, thence through the telco system to the FAA RCC equipment. A regulated amplifier in the RCC equipment accommodates a relatively wide range of voice levels. The adjustment of the regulation threshold is accomplished so that the soft voice is able to properly modulate the transmitter, while the loud voice is limited to prevent overmodulation of the transmitter.

(3) Test Equipment Required.

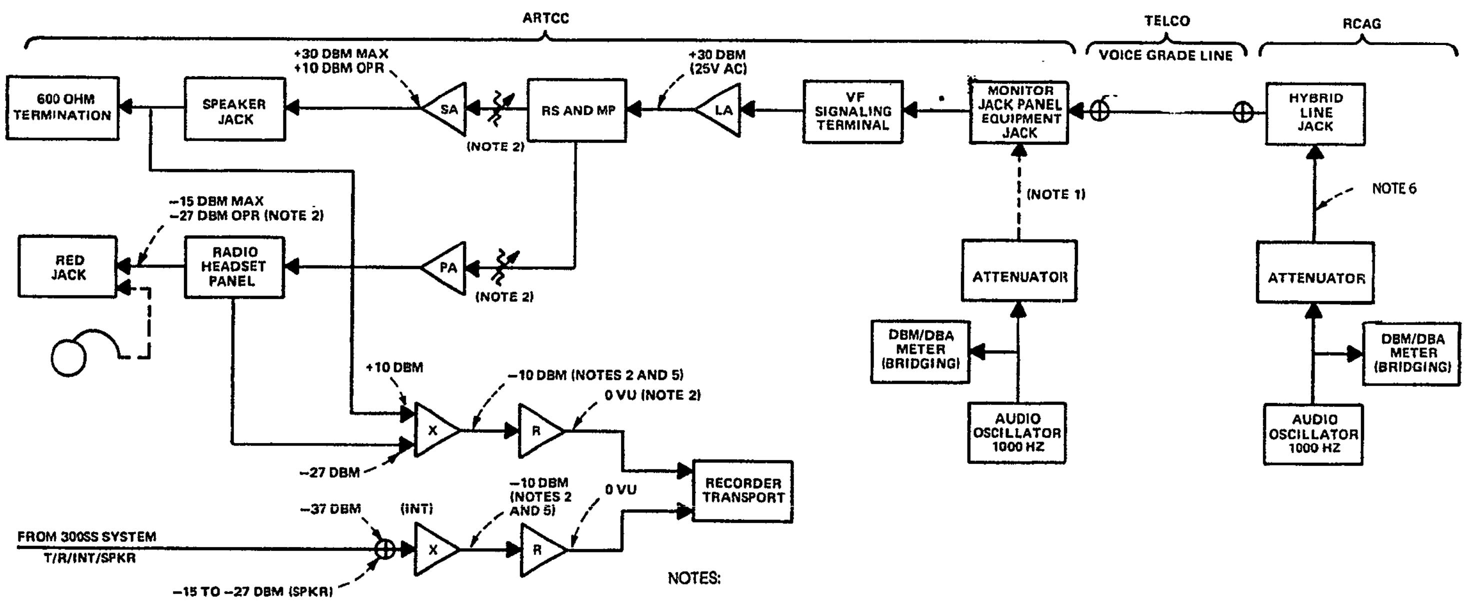
(a) Audio oscillator or function generator, 600-ohm source impedance.

(b) Audio test set FA-9491 or equivalent (test box).

(c) Transmission test set or audio power level meter.

(d) Modulation monitor.

(e) Oscilloscope.



NOTES:

1. A SIMULATED RCAG RECEIVE LEVEL MAY BE INJECTED IN MONITOR EQUIPMENT JACK AT ARTCC.

2. MEASURED WITH RS AND MP GAIN CONTROLS ADJUSTED 20 DB BELOW MAXIMUM SETTING FOR SPEAKER AND 12 DB BELOW MAXIMUM FOR HEAD PHONES.

3. ⊕ IS A TELCO/FAA INTERFACE POINT.

4. NOMINAL LEVELS ARE SHOWN IN THE DIAGRAM. REFER TO THE CHAPTER 3 STANDARDS AND TOLERANCES FOR INITIAL AND OPERATING TOLERANCES OR LIMITS.

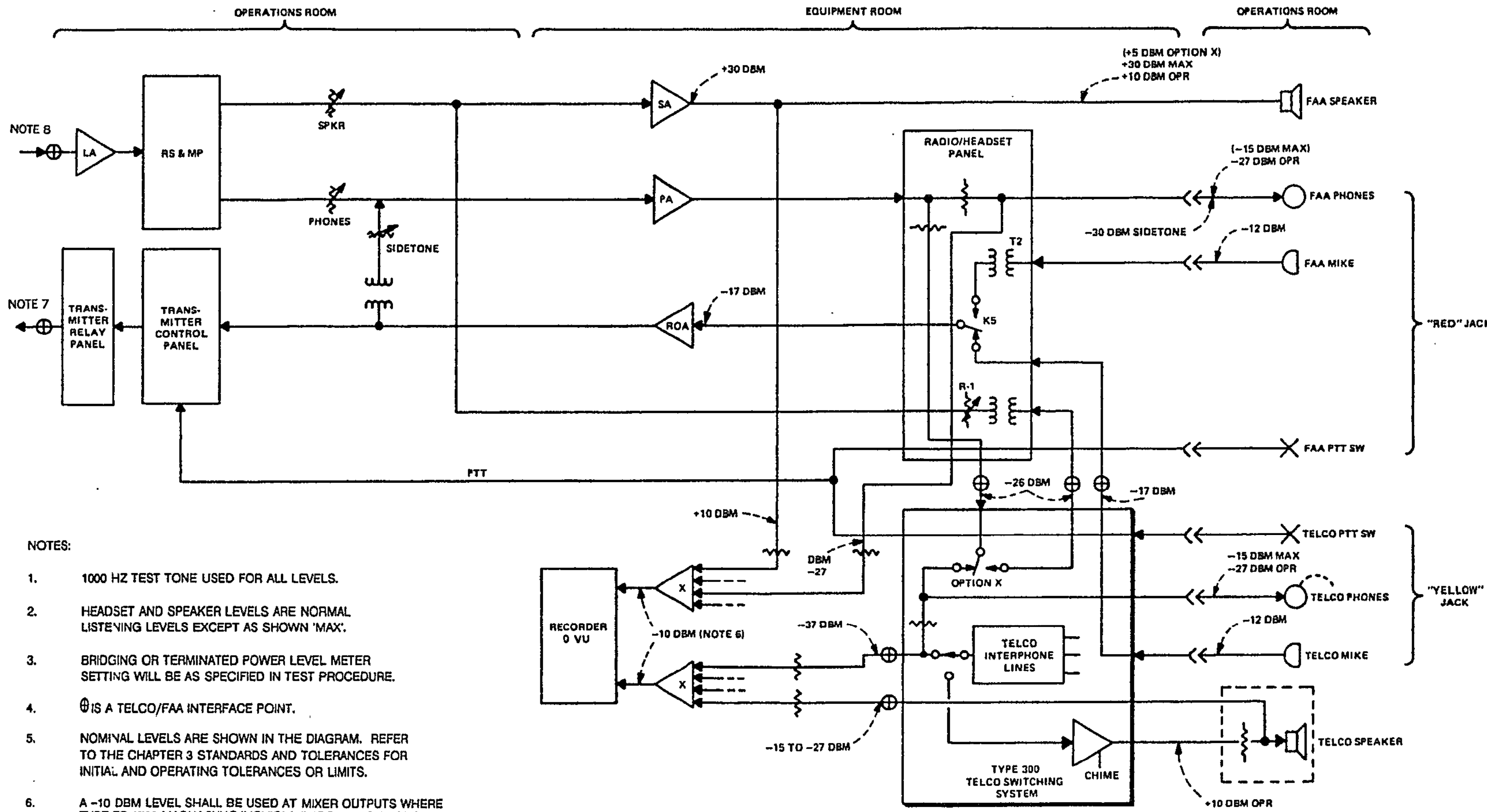
5. A −10 DBM LEVEL SHALL BE USED AT MIXER OUTPUTS WHERE TYPE TR-1720 MAGNASYNC/MOVIOLA RECORDERS ARE USED.

6. INPUT LEVEL WILL DEPEND ON TELCO LINE LOSS AS FOLLOWS:

   a. FAA-S-1142a LINE: −8dBm
   b. LEASED LINE: COMMISSIONED VALUE
   c. ZERO LOSS LINE: −8dBm *

*

Figure 5-5. Receiving Audio Level Lineup Diagram



NOTES:

1. 1000 HZ TEST TONE USED FOR ALL LEVELS.
2. HEADSET AND SPEAKER LEVELS ARE NORMAL LISTENING LEVELS EXCEPT AS SHOWN 'MAX'.
3. BRIDGING OR TERMINATED POWER LEVEL METER SETTING WILL BE AS SPECIFIED IN TEST PROCEDURE.
4. ⊕ IS A TELCO/FAA INTERFACE POINT.
5. NOMINAL LEVELS ARE SHOWN IN THE DIAGRAM. REFER TO THE CHAPTER 3 STANDARDS AND TOLERANCES FOR INITIAL AND OPERATING TOLERANCES OR LIMITS.
6. A -10 DBM LEVEL SHALL BE USED AT MIXER OUTPUTS WHERE TYPE TR-1720 MAGNASYNC/MOVIOLA RECORDERS ARE USED.
7. LEVEL IS DEPENDENT ON TELCO LINE:
   a. FAA-S-1142a LINE: -8dBm
   b. LEASED LINE: COMMISSIONED VALUE
   c. ZERO LOSS LINE: -8dBm
8. LEVEL IS DEPENDENT ON TELCO:
   a. FAA-S-1142a - -17dBm
   b. LEASED LINE - -16dBm
   c. ZERO LOSS LINE: -8dBm

Figure 5-6. ARTCC/300SS Interface Levels

*U.S. GOVERNMENT PRINTING OFFICE:1996-769-016/20101

(d) Readjust RSMP phone volume control or −27dBm at test box meter. DO NOT CHANGE THIS LEVEL UNTIL ALL MIXER AMPLIFIER ADJUSTMENTS ARE COMPLETED.

(e) Unplug the test box.

(8) Mixer/Record Amplifier Adjustments, FAA Loudspeaker.

(a) Terminate FAA speaker line into OSC IN input of test box. Set S-1 to CAL TONE. Set S-2 to SEND/SPKR LEVEL.

(b) Set RSMP selector to SPEAKER position. (Note that test signal from FAA demarcation produces +10dBm on the test box meter.)

(c) Connect bridged transmission test set to output terminals of appropriate mixer amplifier. Beginning with the first mixer channel, adjust loudspeaker input gain for −10dBm output.

(d) Adjust the associated recorder channel amplifier gain for 0 vu output, or as specified per recorder type.

(e) Repeat steps (3) and (4) above for the remaining mixer/recorder channels.

(f) Set RSMP selector to neutral position and disconnect FAA speaker line from test box.

(9) Mixer Amplifier Adjustments, FAA Phone/Telco Phone.

(a) Set RSMP selector to PHONE position. Set test box S-2 to RECEIVE LEVEL. Plug test box into the red jack or the A jack. (Note that test signal from FAA demarcation strip produces −27dBm on the test box meter for red jack and −37dBm for the A jack.)

(b) Connect bridged transmission test set to the output terminals of each respective mixer channel indicated below.

(c) Adjust interphone input gain control for a mixer output of −10dBm.

(d) Plug the test box into the red jack. Adjust gain control for R mixer amplifier to −10dBm output.

(e) Plug test box into the yellow jack. Adjust gain control for I/R mixer amplifier to −10dBm output. Set the telco 300SS turnkey switch to radio.

(10) Mixer Amplifier Adjustments, Telco Speaker.

(a) Operate the telco 300SS turnkey switch to INTERPHONE position. Set RSMP switches to neutral. Set test box S-1 to SEND TONE. Set test box S-2 to SEND/SPKR LEVEL.

(b) Connect −12dBm test box signal to the yellow jack. Activate the telco speaker with loudspeaker (LS) pushbutton on 300SS module. Activate telco indirect access (IA) pushbutton and dial into the H/R (tracker) position.

(c) Test signal will now be heard through telco speaker at the H/R position. Adjust speaker volume control for comfortable listening.

(d) Bridge meter across speaker amplifier B input (SA/B) to H/R mixer amplifier. Readjust H/R telco * speaker volume control for a nominal level as specified in par 71a(5)(g) for the input to the mixer amplifier. *

(e) Bridge transmission test set across output of the H/R mixing amplifier and adjust the SA/B gain control for −10dBm output. Operate telco release (RLS) button.

(f) Operate the IA button and dial into the manual position.

(g) Bridge meter across SA/B input to manual mixer amplifier. Adjust telco speaker volume control for * a nominal level as specified in par 71a(5)(g) for the input to the mixer amplifier. *

(h) Bridge meter across output of I/R mixing amplifier and adjust SA/B gain control for −10dBm output. Operate telco RLS button.

(i) Operate IA button and dial into the I (assistant) position.

(j) Bridge meter across SA/B input to I mixer * amplifier. Adjust I telco speaker volume control for a nominal level as specified in par 71a(5)(g) for the input to the mixer amplifier. *

(k) Bridge meter across output of I mixing amplifier and adjust SA/B gain control for −10dBm output.

(l) Plug a handset into the I jack and operate telco LS pushbutton to transfer test tone to phone side. Adjust the IT/A gain control on I mixer amplifier to −10dBm output.

(m) Adjust associated recorder channel amplifier gain for 0 vu output, or as specified for recorder type.

(n) Operate RLS button and unplug the test box.

(11) Option X (Override) Adjustment.

(a) Set test box switch S-1 to CAL TONE. Set S-2 to SEND/SPKR LEVEL.

(b) Connect FAA speaker line to OSC IN. Set RSMP selector to PHONE position. Test box is not to be plugged into any jack.

(c) Adjust the associated radio headset panel (rhp) attenuator R-1 for +5dBm on test box meter.

(12) Sidetone Adjustment.

(a) Plug the test box into the red jack. Disconnect the FAA speaker line from the test box.

(b) Apply −12dBm to CAL TONE input. Set test box S-1 to SEND TONE and S-2 to RECEIVE LEVEL. Select test channel on TCP and set test box S-3 to PTT ON.

(c) Adjust the audio sidetone control attenuator for −30dBm output on test box meter.

(13) Restoration. Remove test equipment, connect FAA speaker, install fs sender, and obtain aircraft check.

(14) Local Receiver Adjustment.

(a) Apply a 50μV signal, modulated 30 percent 1000Hz to the receiver antenna input connector.

* (b) If a local receiver line amplifier is used, terminate the input line jack of the amplifier with a 600-ohm power level meter. Adjust the receiver audio output to within the initial tolerance specified in paragraph 71a(7). Perform line amplifier adjustments, paragraph 121a(5).

(b)-1 If there is no line smplifier, adjust the receiver audio output to within the initial tolerance specified in paragraph 71a(7). *

(c) Remove test equipment and restore equipment to normal. DO NOT CHANGE ANY ADJUSTMENTS ALREADY MADE IN THE RECORDING OR POSITION EQUIPMENT DURING LOCAL RECEIVER ADJUSTMENTS.

b. Radio Channel Control.

(1) Object. This procedure provides adjustment, on 1000-hertz sine-wave test tone, of the receiving branch elements of the system.

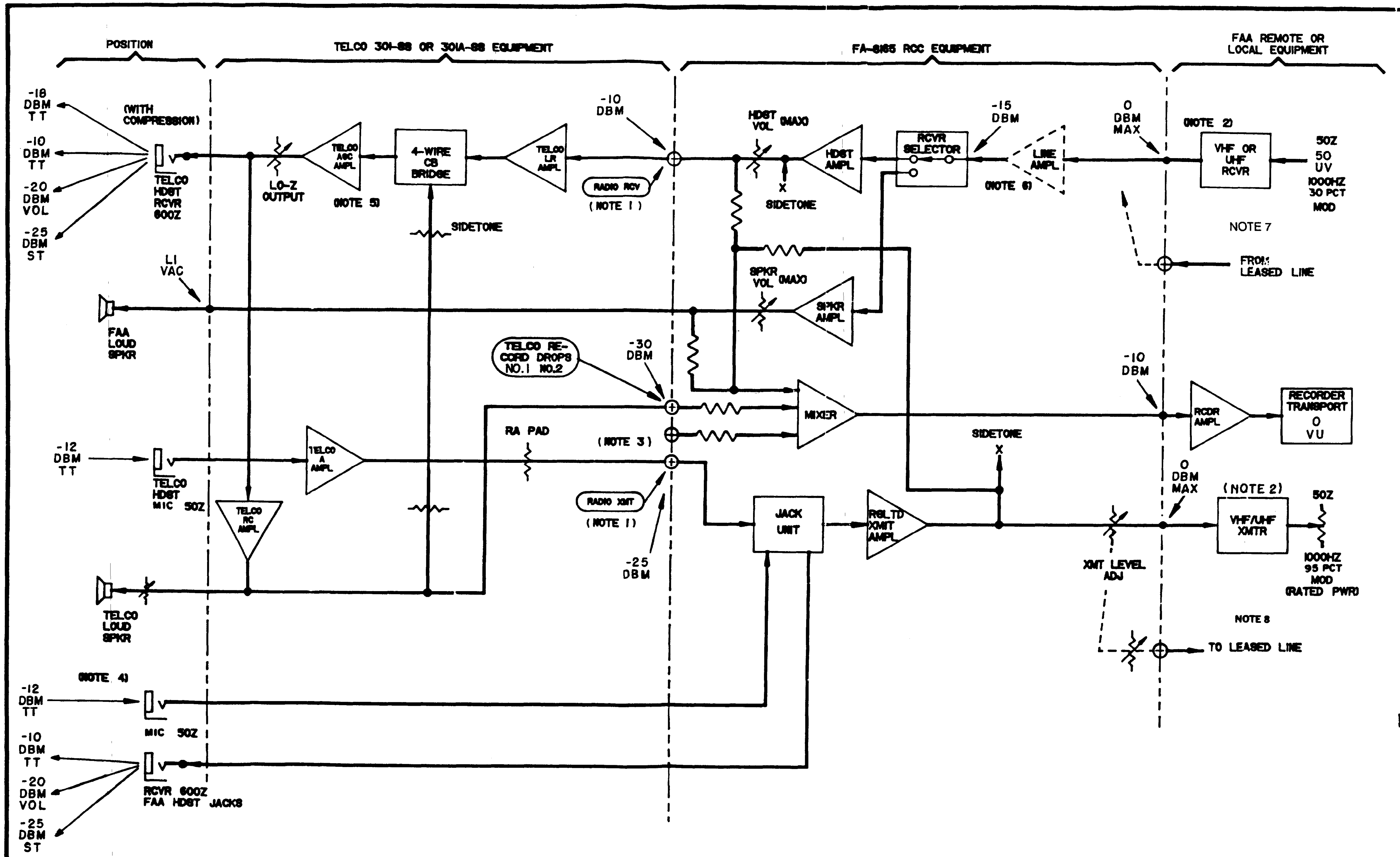
(2) Discussion.

(a) A standard radio frequency (rf) test signal of 50 microvolts is modulated with 1000 hertz at 30 percent in a signal generator or communication service monitor (CSM). This test signal is connected to the 50-ohm antenna input of the radio receiver that is located either at the remote location (RTR) or in the terminal facility. The receiver is adjusted for normal operation. The 600-ohm audio output of the receiver is terminated into a 600-ohm power level meter or audio output meter (receiver test set). The output is adjusted for the nominal required level into the line, radio link, or RCC receiver selector unit. Then, when the receiver is connected into its circuit equipment, for example into the RCC receiver selector, the headset volume control is set to maximum clockwise position, resulting in the correct radio receiver interface level. (See figure 5-6A.) When this is done, and if the telco system is properly adjusted, the 1000-hertz test tone level appearing at the telco headset receiver jack is compatible with the maximum permitted by the Occupational Safety and Health Agency (OSHA). The compression (or agc) amplifier in the telco system limits the signal at the headset receiver jacks. The telco loudspeaker level is obtained by gain adjustment of the speaker amplifier. The telco loudspeaker contains an integral amplifier and volume control. The FAA loudspeaker is driven by a dedicated linear amplifier and has a separate volume control. The nominal telco recording levels are obtained through the telco record drop interface point as shown in figure 5-6A, and are provided from the interphone, telco speaker, and telco phones circuits.

(b) The procedure in this section assumes that the receiving branch amplifier of the solid-state RCC is a linear amplifier of fixed gain. Figure 5-6A indicates that a line amplifier may be installed between the landline or link demarcation strip and the input to the receiver selector unit. This amplifier may be required at some facilities where, for example, a line of FAA-S-1142a characteristics (9 decibels loss) or voice-grade (16 decibels loss) results in a signal drop at the selector input that is too great for proper equipment operation.

(3) Test Equipment Required.

(a) Rf signal generator or CSM, 50-ohm source impedance.



NOTES:

1. FAA/TELCO INTERFACE POINTS DESIGNATED ⊕
2. FOR VARIOUS DEMARCATION STRIP LINE LEVEL STANDARDS SEE THE STANDARDS AND TOLERANCES.
3. DIAGRAM SHOWS SINGLE CHANNEL TELCO RECORDING WITH PROVISION FOR A SECOND RECORDING CHANNEL.
4. MICROPHONE EQUIVALENT TEST TONE LEVEL BASED ON USE OF HEADSET.
5. MAY BE A LINEAR AMPLIFIER AT SOME LOCATIONS.
6. AMPLIFIER REQUIRED IF RECEIVED LEVEL TOO LOW.

* 7. -8dBm FOR ZERO LOSS LINES; COMMISSIONED VALUE FOR LEASED LINES; −17 dBm FOR FAA-S-1142a LINES.

8. -8dBm FOR ZERO LOSS LINES; COMMISSIONED VALUE FOR LEASED LINES; −8 dBm FOR FAA-S-1142a LINES. *

FIGURE 5-6A. AUDIO TRANSMISSION LEVEL DIAGRAM
(FA-8165 WITH TELCO 301-SS OR 301A-SS)

(b) Audio oscillator or function generator, 600-ohm source impedance.

(c) Audio test set FA-9491 or equivalent (test box).

(d) Receiver test set or audio power level meter.

(e) Transmission test set or audio power level meter.

(f) Vacuum-tube voltmeter (vtvm).

(g) Fixed attenuator, 20-decibel, balanced (H-pad), 600/600-ohm impedance.

NOTE: The audio test set (test box) provides an approximate equivalent of the rated microphone level at the microphone jacks of the controller's position console when it is driven by a 1000-hertz, 600-ohm audio oscillator or function generator with a sine-wave output. The test box contains provisions for measuring receive levels at these position jacks and contains a push-to-talk (ptt) switch and a 600-ohm calibrating resistor for ensuring that the audio oscillator input (when used in transmitting branch lineup) is adjusted for the specified microphone equivalent level. A switch is used to transfer the audio oscillator from the calibrating resistor to the microphone circuit. Another switch permits transferring the power level meter between send and receive branches.

(4) Conditions.

(a) Refer to paragraph 92 of Order 6480.6A for the basic test conditions.

(b) The procedure that follows is on an end-to-end basis. However, it may be impractical to use a test signal from either terminal, over the line or radio link, to adjust the rest of the system. In such a case, it is permissible at one terminal to simulate the test signal received from the other terminal by disconnecting the line or radio link circuit at the demarcation strip and substituting a locally-generated test signal equal in level to that normally obtained. As there is a variety of possible line losses or link arrangements, the procedure does not include specific levels to be simulated. However, the appropriate level should be available from facility commissioning records for use with this lineup procedure.

(5) Detailed Procedure – Receiving Branch.

(a) Ensure that the receiver under test is adjusted for normal operation and meets the required operating standards.

(b) Disconnect the receiver audio output from the line, radio link, or receiver selector circuit to which it is normally connected.

(c) Connect a 600-ohm receiver test set or a 600-ohm terminated audio power level meter to the 600-ohm output of the receiver.

(d) Connect the rf signal generator or CSM to the receiver antenna input and inject a channel-frequency signal of 50μV, 1000Hz, modulated 30 percent.

(e) Adjust the audio output level of the receiver (or line amplifier) to within the initial tolerance specified in paragraph 71b(1)(a) or (b).

(f) Reconnect the receiver to the circuit where it is normally connected. Adjust all receivers per steps (b) through step (e).

(g) Select FAA on the FAA/telco switch (if applicable).

(h) Plug the test set into the FAA headset jacks and connect the audio power level meter to the AUDIO OUT connectors of the test set with switch S-2 in the RECEIVE LEVEL position. At the selector unit, select HEADSET. At the volume control unit, place the HEADSET VOLUME control fully clockwise and the SPEAKER VOLUME control fully counterclockwise. The level measured at the FAA headset jack should be within the initial tolerance specified in paragraph 71b(1)(e).

(i) Select telco on the FAA/telco switch (if applicable).

(j) Plug the test set into the telco jack and connect an audio power level meter to the AUDIO OUT connector on the test set with S-2 in the RECEIVE level position. Set the telco auxiliary volume control (on the speaker panel) fully clockwise (if applicable). Measure the level; it should be within the initial tolerance specified in paragraph 71b(1)(e).

(k) Bridge a transmission test set or audio power level meter at the FAA/TELCO RADIO RECEIVE interface. The level should be within the initial tolerance specified in paragraph 71b(1)(d).

(l) Adjust the FAA headset volume volume control for maximum and adjust the telco headset gain contrl for -20dBm at the telco headset jack.

(m) Bridge the transmission test set or audio power level meter at the telco RECORD DROP interface point. The level should be within the initial tolerance specified in paragraph 71b(1)(h).

(n) Disconnect the voice recorder input and terminate the input with a 600-ohm meter. Disconnect the telco RECORD DROP. Measure the input level; it should be within the initial tolerance specified in paragraph 71b(3)(a). If not, adjust R17 in the recorder monitor module for the specified level.

(o) Reconnect the voice recorder input, and adjust the recording amplifier gain for the initial tolerance specified in pargraph 71b(3)(b).

(p) Obtain access to the speaker by opening the panel on the front audio unit. Connect the vtvm across the speaker terminals.

(q) At the selector unit, select SPEAKER. At the audio unit, increase the speaker input by slowly turning the SPEAKER VOLUME control clockwise. At maximum volume (fully clockwise), the speaker input voltage should be within the initial tolerance specified in paragraph 71b(1)(g). Remove the vtvm and restore the speaker access panel.

(r) Reconnect the telco RECORD DROP that was disconnected in step (n).

(s) Disconnect all test equipment and return the position to operating configuration.

NOTE: This concludes the receiving branch adjustment. Sidetone is checked during the transmitting branch adjustment.

122. RCAG LINEUP.

a. Object. See paragraph 120a(1).

b. Discussion. See paragraph 120a(2).

c. Test Equipment. See paragraph 120a(3).

* **d. Conditions.** The procedure that follows is on an end-to-end basis. However, it may be impractical to use a test signal from the ARTCC, over the line or radio link, to adjust the rest of the system. In such a case, it is permissible at the RCAG to simulate the test signal received from the ARTCC by disconnecting the line or radio link circuit at the demarcation strip and substituting a locally generated test signal equal in level to that normally obtained. As there are a variety of possible line losses or link arrangements, the procedure does not include any specific levels to be simulated. However, the appropriate level should be available from facility commissioning records for use with this lineup procedure. *

e. Modulation Adjustments.

(1) At the transmitter site, adjust the modulator gain control for 95 percent modulation on the ARTCC test tone.

(2) This completes the transmit poriton of the position lineup. Remove test equipment and restore the circuit to AT control or proceed with RCAG receiver adjustments.

f. Receiver Output Level Adjustment.

(1) Bridge a transmission test set across the telco line at the demarcation strip.

(2) Inject a $50\mu V$ rf signal into the receiver; modulate the signal 30 percent with a 1000Hz tone.

(3) Adjust the receiver audio output the level to the telco line as specified in paragraph 72b. This completes the RCAG adjustments.

123.-129. RESERVED.

Section 3. SPECIAL MAINTENANCE PROCEDURES

130. GENERAL.

The procedures of this section are not scheduled but are useful when evaluating a communications channel, such as troubleshooting and the determination of the solutions to special problems. Log for future reference the parameters obtained during tests of a normal channel. Refer to this baseline data when difficulties in the channel arise. Procedures provided in this section include frequency response, noise, and signal-to-noise ratio (snr) measurements. (These parameters can be easily measured with the Wavetek transmission test system by using procedures found in its instruction book.) This test system consists of the model 424 sweep transmitter and model 425 transmission test level receiver. Facilities lacking this equipment should substitute locally-available audio oscillators and transmission test sets for the sending generator and receiving meter respectively, then use manual sweep techniques. Refer to test equipment table 5-1.

131. FREQUENCY RESPONSE MEASUREMENT.

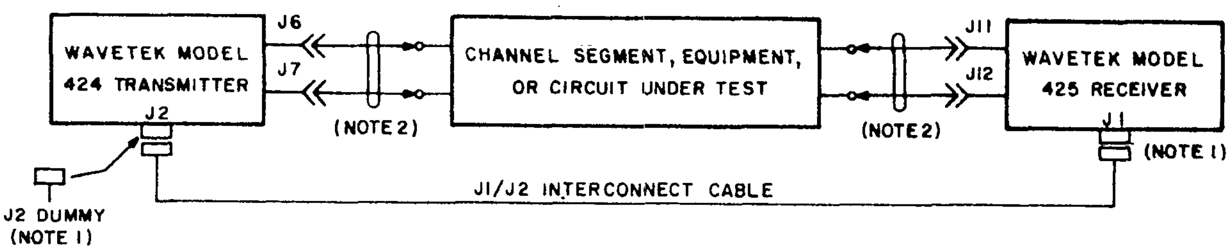
It is impractical and unnecessary to measure the audio frequency (af) response (audio frequency attenuation) of an a-g communication channel on an end-to-end basis. Instead, selected segments are measured and the results compared to previously-recorded data to ascertain any degradation or significant change. Frequency attenuation checks have been made much more efficient with the recent acquisition of modern transmission test sets, such as the Wavetek Model 424/425 Transmission Level Test Set, which are comprised of individual transmitter and receiver units. Each ARTCC facility has been provided with one of these sets. (Refer to figure 5-7.) Table 5-2 lists the recommended system segments on which frequency response runs should be made using the Wavetek set and accomplished at the discretion of the ARTCC maintenance supervisor. There is no periodic requirement for such checks; no official standards and tolerances have been established. The use of commissioning baseline data, however, may provide fast and efficient resolution of system problems indicating the need for response runs. Order 6000.22 provides the periodic maintenance requirement and the procedures for making frequency attenuation checks of the leased circuits between the ARTCC and the RCAG (including BUEC requirements).

Table 5-2. FREQUENCY RESPONSE APPLICATIONS

Sending Terminal (Wavetek 424)	*Inclusive System Components*	*Receiving Terminal (Wavetek 425)*
a. Position patch panel channel jack	Receiver selector and mixing panel (rsmp)	FAA headset receiver jack
b. Position patch panel channel jack	Rsmp	FAA speaker jack
	Speaker amplifier (SA)	
c. Position patch panel channel jack	Rsmp	Recorder (mixer amplifier output)
	PA	
	Radio headset panel (Rhp)	
	Mixer (X)	
d. FAA Position microphone jack	Rhp	Patch panel position plug
	Regulated output amplifier (ROA)	
	Transmitter control panel (TCP)	
e. Position sidetone (at FAA microphone jack)	Rhop (send branch)	FAA headset receiver
	ROA	
	PA	
	Rhp (receive branch)	
f. RCAG line at monitor jackfield	Line amplifier (LA)	Position patch panel channel jack
g. Local vhf or uhf receiver	LA	Position patch panel channel jack
h. Position patch panel channel jack	Transmitter relay panel (TRP)	Monitor jackfield equipment jack
	Voice frequency signaling system (VFSS)	
i. Position patch panel channel jack to local transmitter	TRP Transmitter	Transmitter output rf body with modulation monitor/scope and dummy load

Table 5-2. FREQUENCY RESPONSE APPLICATIONS (Continued)

Sending Terminal (Wavetek 424)	*Inclusive System Components*	*Receiving Terminal (Wavetek 425)*
j. RCAG receiver rf input (from CSM) modulated 30% at 1000Hz	Vhf or Uhf receiver VFSS	Hybrid equipment jack at RCAG
k. ARTCC line at hybrid equipment jack	VFSS LA or ROA Vhf or Uhf transmitter	Transmitter output rf body with modulation monitor/scope and dummy load
l. ARTCC at hybrid line jack (send)	Leased transmit circuit	RCAG at hybrid line jack (receive)
m. RCAG at hybrid line jack (send)	Leased receive circuit	ARTCC at hybrid line jack (receive)



NOTE:

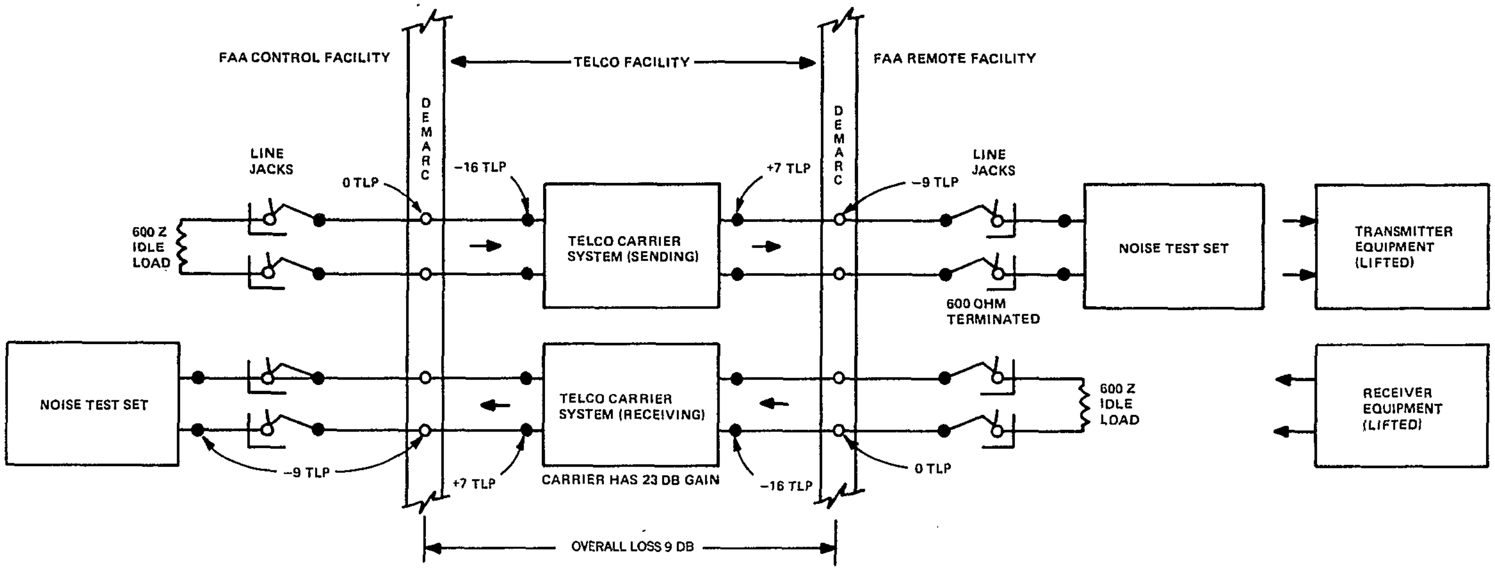
1. IF THE TRANSMITTER AND RECEIVER UNITS MUST BE IN DIFFERENT LOCATIONS FOR CERTAIN TESTS, THE DUMMY SOCKET J2 MUST BE PLUGGED INTO THE TRANSMITTER UNIT J2, WITH THE J1 END OF THE J1/J2 INTERCONNECT CABLE PLUGGED IN THE RECEIVER.

2. TERMINAL IMPEDANCE IS NOMINALLY 600 OHMS.

Figure 5-7. Basic Frequency Response Test Arrangement

132. NOISE AND SIGNAL-TO-NOISE RATIO (SNR). Measure noise either in absolute noise units (e.g., dBa, dBrn, or dBm) or as snr derived from a measured noise power compared with measured test-tone signal power. Measure telephone circuit noise (on FAA-S-1142a and voice-grade circuit interconnecting facilities) by using the procedures and parameters of Order 6000.22. The noise-measuring procedures of that directive have been changed to conform to the Bell System Practices using dBrnc noise units on a mileage band basis, as measured with test sets equipped with C-message noise-weighting filters. Figure 5-8 is a typical test arrangement for measuring noise at the terminals of a channel or a unit of channel equipment, such as an amplifier. In this method, directly connect the noise test set, using the scale of the meter corresponding to the units of measurement desired. Noise value obtained with one type of weighting can be readily converted into other units by means of the nomograms of Appendix 3. To obtain snr measurements, obtain a reference test tone signal level in dBm at the point of measurement. Then measure the idle noise at the same point in the absence of the test tone.

133.-139. RESERVED.



NOTE: LEVELS SHOWN ARE FOR FAA-S-1142a LINES.

Figure 5-8. Setup for Noise Measurement

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CHAPTER 6. FLIGHT INSPECTION

140. GENERAL.

Flight inspections are made to verify the overall performance of an air-to-ground communication facility. The instructions for flight inspection are contained in OAP 8200.1, United States Standard Flight Inspection Manual. Flight inspections are required as specified in the flight inspection manual and when requested by regional authority.

141. ACTIVITIES REQUIRING A CONFIRMING FLIGHT INSPECTION.

Flight inspections of commissioned communication facilities are normally accomplished in conjunction with other primary navigational aids. Most situations would not warrant the expense of a special trip or priority flight inspection. (Detailed policy is outlined in OA P 8200.1.) The following activities should be considered for calling for a confirming flight inspection.

a. Major changes in local obstructions or buildings that may affect the signal strength or coverage.

b. Change in output level for the purpose of increasing or decreasing service area.

c. Frequency changes.

d. Replacement, relocation, or reorientation of antennas.

142. ACTIVITIES NOT REQUIRING A CONFIRMING FLIGHT INSPECTION.

The following may be accomplished by electronic technicians without recourse to flight inspection:

a. Replace any or all tubes.

b. Replace or repair transmitter components.

c. Retune all stages of the transmitter.

d. Measure and adjust voice modulation percentages to values established during flight inspection.

e. Accomplish other maintenance procedures, provided the conditions are restored to those which existed at the time of the last flight inspection as reflected in the current FAA Form 6600-6.

143.-149. RESERVED.

CHAPTER 7. MISCELLANEOUS

* **150. PAD INSTALLATION TO ACCOMMODATE ZERO LOSS LINES.**

a. The following equipment should not require the addition of external attenuators (pads). Instead, the equipment listed or its associated equipment should be adjusted to the required levels.

VFSS Equipment	Misc. Equipment
CA-1620	Local/Remote GRR receivers
CA-1621	Local/Remote GRR transmitters
CA-1708	Transmit/Receive line amplifiers
FA-5390	
FA-8187	
FA-8735	
Grim Tone Channeling	
Grim Vodata	
Tellabs	

b. Backup emergency communication equipment (BUEC) is addressed in Handbook Order 6500.9A, Maintenance of Backup Emergency Communication (BUEC) Facilities.

c. Other (regional purchased) equipment may require the installation of pads to accommodate the increased audio alignment levels established for zero loss lines.

* (1) If pads are required, they shall be installed on the receive side between the master demarc system (MDS) and the equipment, or the mini demarc system (mds) and the equipment. Installing the pads on the receive side will improve the signal-to-noise ratio of the circuit.

(2) If pads are required, the recommended method of installation is in a separate equipment rack mounted next to the MDS or main FAA/telco demarc on telco type "66" punch down blocks. It is recommended that pads that push onto the "66" blocks be utilized. The following list is a possible source for the required materials.

ITEM	MANUFACTURER
Pad Rack	EMCOR
"66" Punch Block (P/N S66M2-5WBF/M)	Siemons Co.
Punch Block Fixed Pad (P/N 966XX0)	Larus Corp.
Punch Block Variable Pad (P/N 966931)	Larus Corp.

* **151.-159. RESERVED.** *

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APPENDIX 1. CERTIFICATION REQUIREMENTS

Table 1A. OVERALL EN ROUTE AIR-TO-GROUND COMMUNICATIONS CHANNEL SERVICES

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
	Overall certification is based on the knowledge that the constituent parts are properly certified. There are no overall service certification parameters.	

NORMAL CERTIFICATION INTERVAL: Quarterly

* **MAXIMUM CERTIFICATION INTERVAL:** 125 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at ARTCC, CERAP, or IFSS.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: All en route air-to-ground channel services certified.

Table 1A. OVERALL EN ROUTE AIR-TO-GROUND COMMUNICATIONS CHANNEL SERVICES (with VSCS)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
	Overall certification is based on the 6690.3, par. 72b(2), 73b, 73f knowledge that the constituent parts are properly certified. There are no overall service certification parameters. Review of chatterlog and the maintenance log, after the successful no-fault execution of the automated verification process (AVP) for a-g switches, g-g nodes and discrete monitor and controller (DMC) A and B for the service provided.	

NORMAL CERTIFICATION INTERVAL: Daily.

MAXIMUM CERTIFICATION INTERVAL: 96 hours

PERSONS RESPONSIBLE FOR CERTIFICATION: Airway Facilities NAS operations manager, NAS area specialist, or Airway Facilities system specialist.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: All en route air-to-ground channel services certified.

Table 2. CONTROL FACILITY SYSTEMS (EN ROUTE)

Service	*Certification Parameter*	*Reference Paragraph* *STDS and TOL/LIMITS*
1. Operational continuity	Operational check for each channel	6470.29A None (go/no go)
2. Voice quality	Audio transmitting quality	None (see par. 102)
	Audio receiving quality	None (see par. 102)

NORMAL CERTIFICATION INTERVAL: Quarterly.

* **MAXIMUM CERTIFICATION INTERVAL:** 125 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at ARTCC, CERAP, or IFSS.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: Control facility communications certified.

Table 2A. VSCS SYSTEM

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
1. The VSCS system level certification is part of the en route air-to-ground communications service certification requirements.	Quarterly diagnostics of a-g switches, g-g nodes and discrete monitor and controller(DMC) A and B.	6690.3, par 72b(4), 73c, 73d, 73g

NORMAL CERTIFICATION INTERVAL: Quarterly.

* **MAXIMUM CERTIFICATION INTERVAL:** 125 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Airway Facilities system specialist at ARTCC.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: VSCS certified.

Table 3. OVERALL A-G COMMUNICATIONS TRANSMITTER/RECEIVER SYSTEMS (LOCAL)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
	Overall certification is based on the knowledge that the constituent transmitters and receivers are properly certified. There are no overall system certification parameters.	

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at local transmitter/receiver facility.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: Local communication frequencies certified.

Table 4. EN ROUTE A-G COMMUNICATIONS TRANSMITTER SUBSYSTEMS (LOCAL)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
Voice quality	Audio transmitting quality	None (see 6470.29A, par: 102)
Coverage	Transmitter power output	6580.5, par. 124a or 126a
	Modulation	6580.5, par. 125a or 126d

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at local transmitter/receiver facility.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: Local transmitter (identity of frequency, e.g., 123.4MHz) (main and/or standby) certified.

Table 5. EN ROUTE A-G COMMUNICATIONS RECEIVER SUBSYSTEMS (LOCAL)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
Voice quality	Audio receiving quality	None (see 6470.29A, par. 102)
Coverage	RF sensitivity	6580.5; par. 131a; 132a; or 133a

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at local transmitter/receiver facility.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: Local receiver (identity of frequency, e.g., 123.4MHz) (main and/or standby) certified.

Table 6. OVERALL A-G COMMUNICATIONS TRANSMITTER/RECEIVER SUBSYSTEMS (REMOTED)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
Operational continuity	Operational check for each channel and each frequency	None (go/no go)

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at remoted transmitter/receiver facility

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: RCAG or IFST/IFSR communications frequencies certified.

Table 7. EN ROUTE A-G COMMUNICATIONS TRANSMITTER SUBSYSTEMS (REMOTED)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
Voice quality Coverage	Audio transmitting quality	None (sec 6470.29A, par. 102)
	Transmitter power output	6580.5, par. 124a or 126a
	Modulation	6580.5, par. 125a or 126a

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at remoted transmitter/receiver facility.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: RCAG or IFST transmitter (identity of frequency, e.g., 123.4MHz) (main and/or standby) certified.

Table 8. EN ROUTE A-G COMMUNICATIONS RECEIVER SUBSYSTEMS (REMOTED)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/LIMITS*
Voice quality	Audio receiving quality	None (see 6470.29A, par. 102)
Coverage	RF sensitivity	6580.5, par 131a, 132a or 133a

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technician at remoted transmitter/receiver facility.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: RCAG or IFSR receiver (Identity of frequency, e.g., 123.4MHz) (main and/or standby) certified.

Table 9. BACKUP EMERGENCY COMMUNICATION (BUEC) SYSTEM (CM-200/CS-2330RCE CONFIGURATION)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/Limits*
Operational continuity (Between ARTCC and local BUEC's and between ARTCC and each remote BUEC)	Operational check	None (go/no go)
Voice Quality	Transmit/Receive Audio Quality	None (see 6470.29A, Par. 102)

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technicians at BUEC control facility.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: BUEC (identity of frequency e.g., 123.4 MHz) certified.

Table 10. BUEC TRANSMITTER / RECEIVER SUBSYSTEM (CM-200/CS-2330RCE CONFIGURATION)

Service	*Certification Parameter*	*Reference Paragraph STDS and TOL/Limits*
Coverage	Rf power output Modulation Receiver sensitivity Receiver Audio Output	Order 6580.5, Paragraph 124a Order 6580.5, Paragraph 125a Order 6580.5, Paragraph 134a Order 6470.29A, Paragraph 72b

* **NORMAL CERTIFICATION INTERVAL:** Annually

MAXIMUM CERTIFICATION INTERVAL: 460 days *

PERSONS RESPONSIBLE FOR CERTIFICATION: Electronics technicians at BUEC facility.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: BUEC transmitter/receiver (identity of frequency e.g., 123.4 MHz) certified.

APPENDIX 2. TRANSMITTER MODULATION MEASUREMENT

1. GENERAL.

To measure modulation on test tone or voice peaks, connect the transmitter to a dummy load, a modulation monitor, and an oscilloscope.

2. THE TRAPEZOIDAL PATTERN.

a. The trapezoid modulation pattern offers an excellent method of checking transmitter distortion and modulation percentage. Figure 1 of this appendix illustrates how the radio frequency (rf) and audio signals combine to produce the trapezoidal pattern.

WARNING: HIGH VOLTAGE IS PRESENT ON EXTERNAL TEST LEADS WHEN MAKING THIS MODULATION CHECK.

(1) Do not apply the modulated rf carrier directly to the vertical deflection plates. Obtain suitable output from the modulation monitor, which converts the modulated transmitter rf output signal to a 1000kHz modulated rf signal. Then apply this signal to the vertical input of the oscilloscope.

(2) Only a small portion of the audio voltage is applied to the horizontal deflection plates of the oscilloscope. Observe caution to avoid contacting the high voltage present at the modulator test points.

NOTE: Avoid using the audio output from the modulation monitor for horizontal drive to the oscilloscope. Use audio ahead of the modulated stage of the transmitter, preferably the final output of the modulator, for the horizontal drive source.

(3) Figure 2 shows a typical test setup for use with a uhf single-channel transmitter. A similar setup for vhf transmitters will work equally well by bridging the oscilloscope horizontal input across a suitable audio signal source.

b. Many modulation problems can be identified by analysis of the trapezoidal pattern. Use a simple phase-shift network in the oscilloscope horizontal input line. This phase-shift network may be made up of 0.01μf capacitor in series with the audio line and a 50,000-ohm potentiometer in parallel with the audio line. In figure 3, item A shows a normal 100-percent modulated signal with good linearity. Convex or concave sloping sides indicate linearity problems in the final amplifier. Item B shows an overmodulated condition, and item C indicates an audio phase shift in the transmitter, common to some degree in most transmitters. Items D through F show various kinds of distortion; item G is an overmodulated transmitter with excessive screen voltage on the class C modulated stage.

3. THE ENVELOPE PATTERN.

a. In Figure 5, items A through F, shows various modulation patterns with the oscilloscope adjusted and connected for the envelope pattern technique (test arrangement in figure 4). Item A in figure 5 is a normal, 100-percent modulated pattern. Item B shows a "typical" overmodulated pattern. Item C is an overmodulated pattern showing the effects of regenerative feedback. Item D is an overmodulated pattern showing the effects of excessive screen voltage in relation to the plate voltage in the modulated stage. Item E illustrates crossover distortion caused by excessive grid bias on the modulator tubes. Item F is a pattern caused by speech amplifier clipping.

b. Figures 6 and 7 are nomographs for determining percent of modulation (by either trapezoid or envelope pattern) without calculations.

4. MODULATION ADJUSTING TECHNIQUES.

Set the transmitter voice modulation as close as possible to 95 percent without overmodulating the transmitter. Request a controller to transmit a standard voice test count, and increase the transmitter audio gain until a few points of overmodulation can be seen on an oscilloscope. Then slightly decrease the transmitter audio gain so that the overmodulation peaks no longer occur.

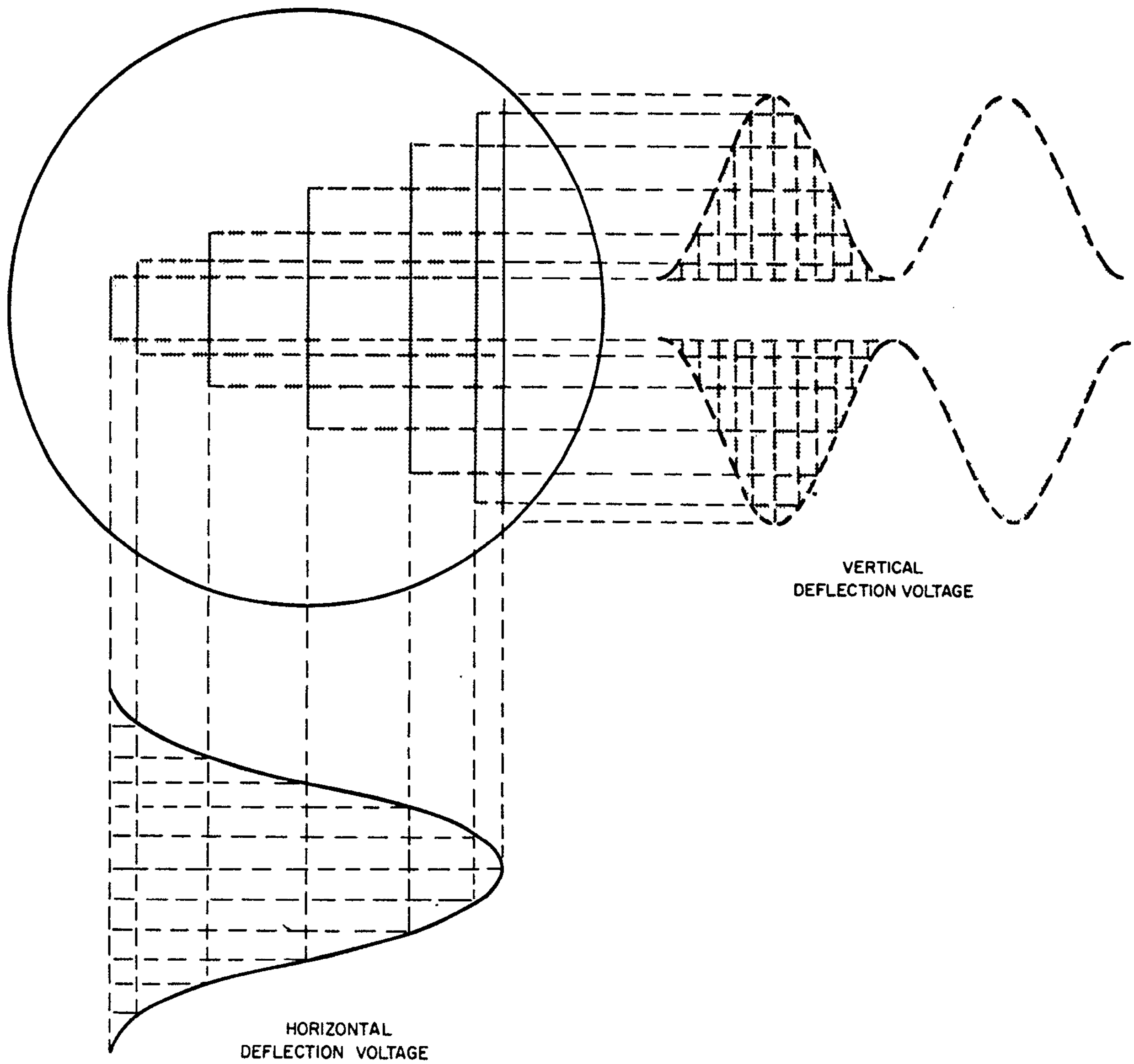

Figure 1. Production of Trapezoidal Pattern

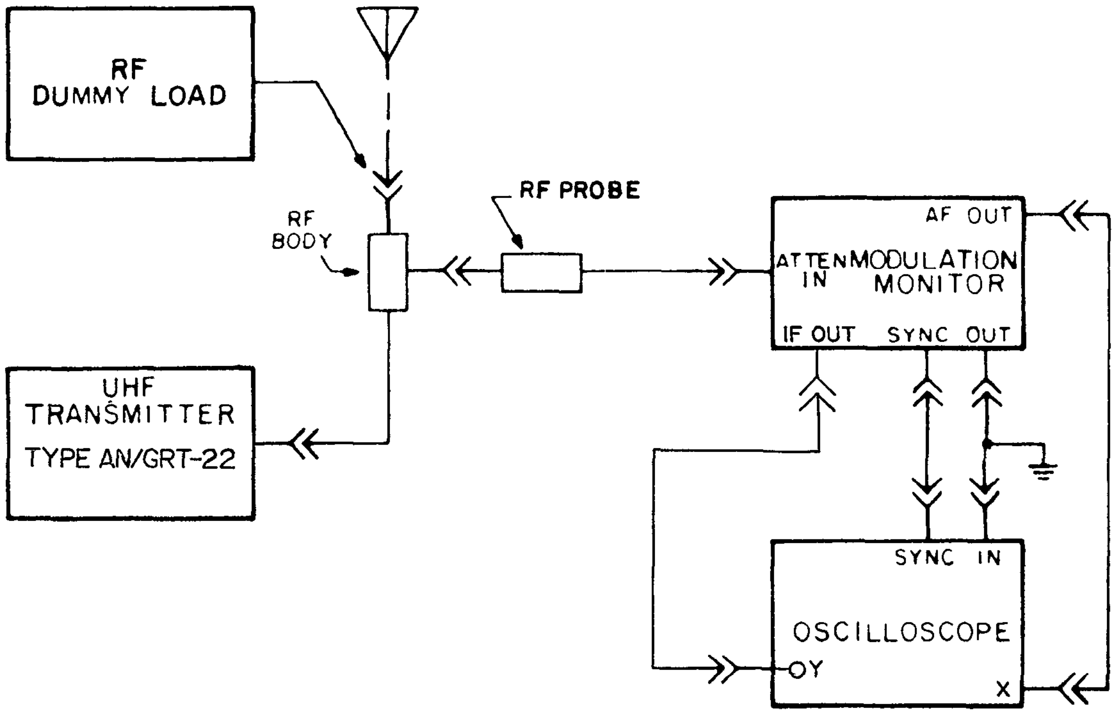

Figure 2. Modulation Measurement by the Trapezoidal Pattern

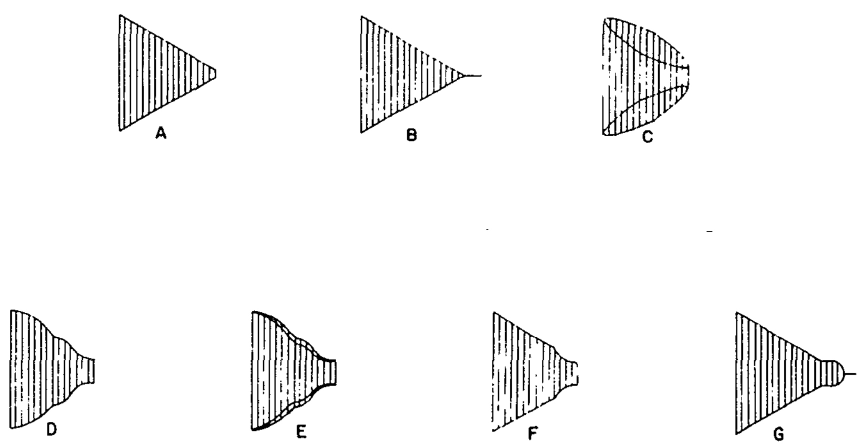

Figure 3. Various Trapezoidal Patterns

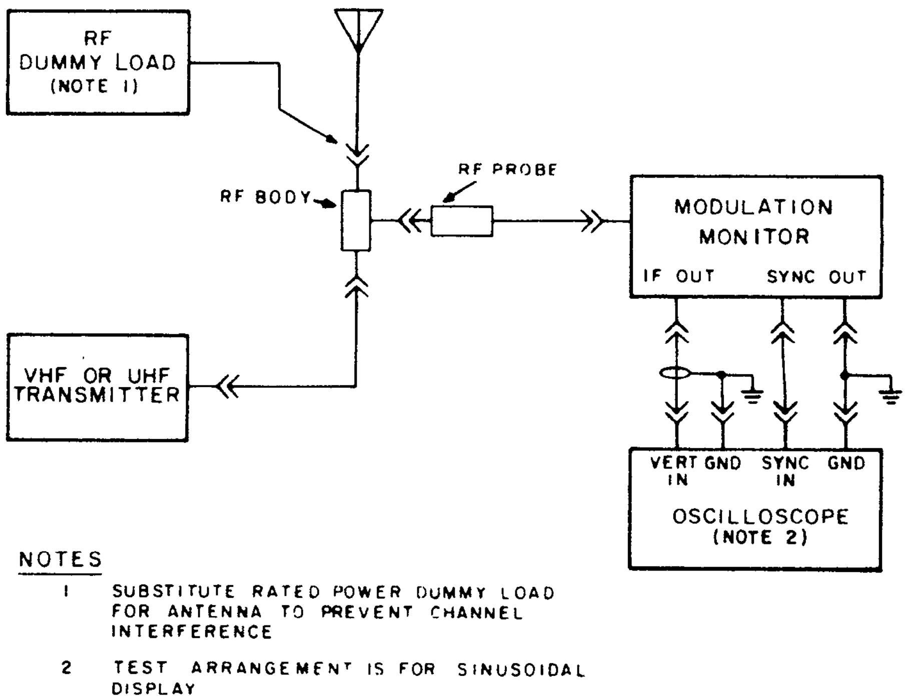

Figure 4. Modulation Measurement by the Envelope Pattern

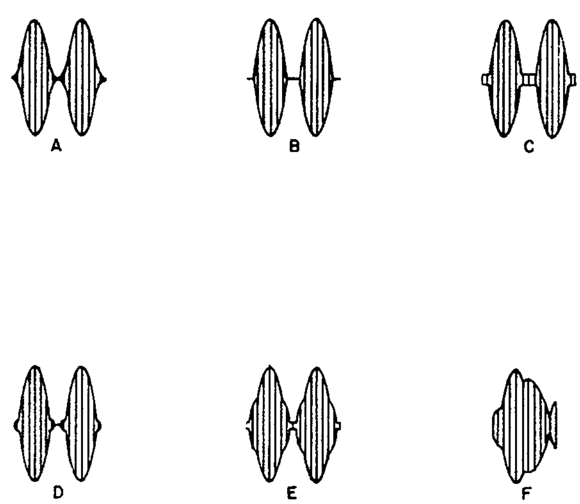

Figure 5. Various Envelope Patterns

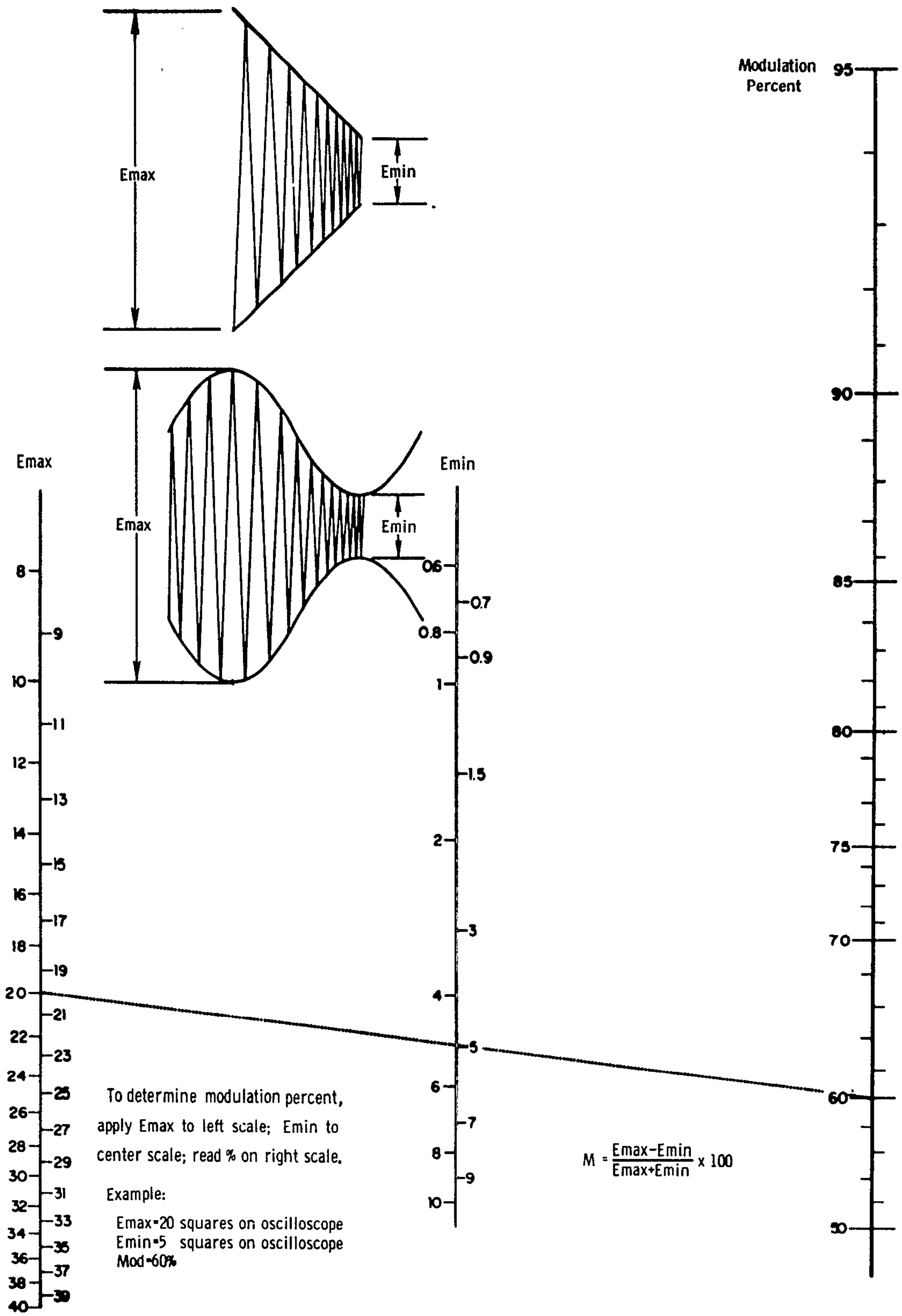

Figure 6. Nomograph for Percentage of Modulation — 50 to 95 Percent

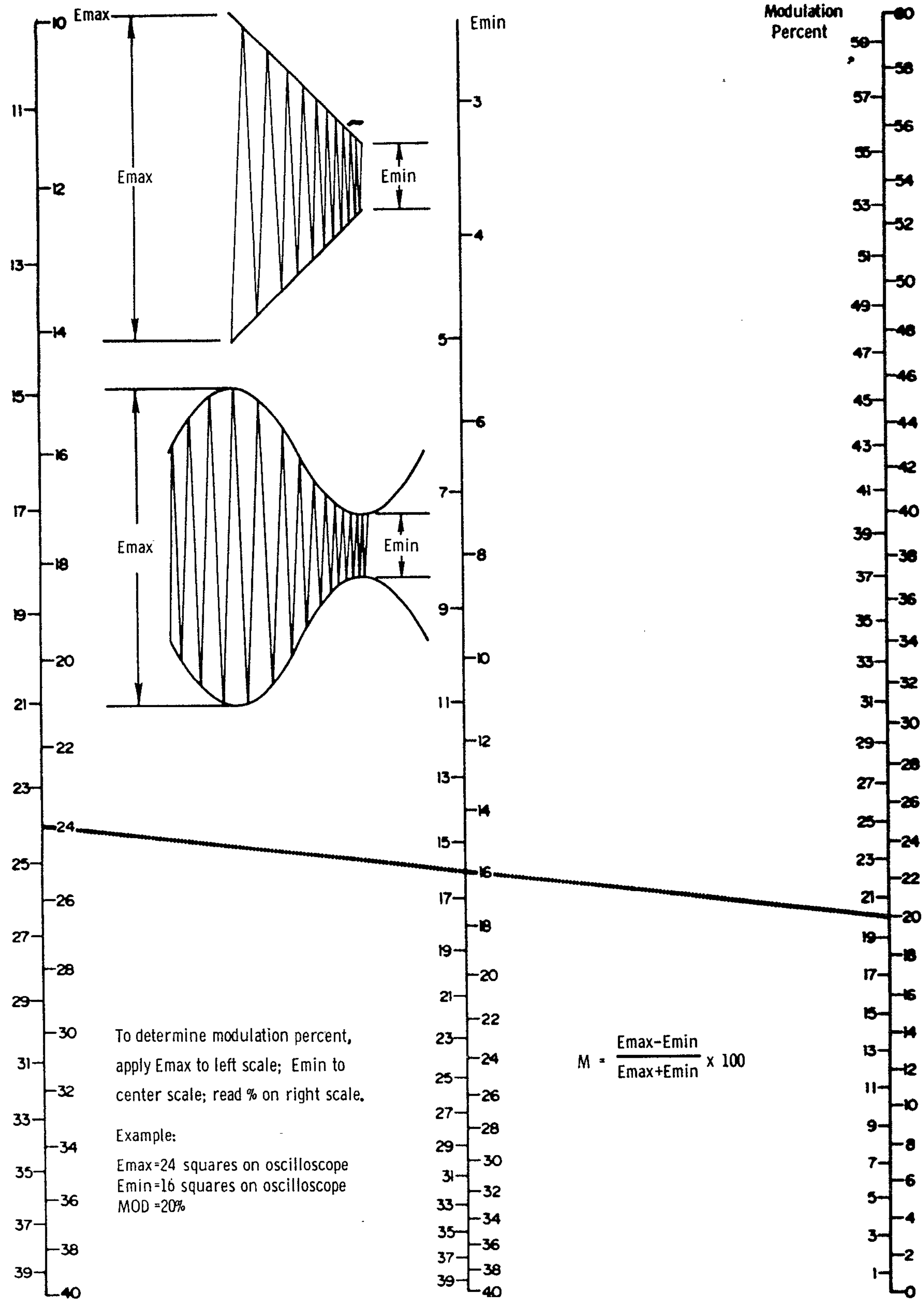

Figure 7. Nomograph for Percentage of Modulation — 0 to 60 Percent

U.S. Department
of Transportation
**Federal Aviation
Administration**

Memorandum

Subject: INFORMATION: Suggested improvements to Order 6470.29A, Maintenance of En Route Air-to-Ground Communications Facilities

Date:

From: ____________________
Signature and title

Reply to
Attn of: ____________________
Facility Identifier
AF Address

To: Manager, National Engineering Field Support Division, ASM-600

Problems with present handbook:

Recommended improvements:

* U.S. GOVERNMENT PRINTING OFFICE: 1990-768-016/20140